Packet Over SONET Module Installation and User Guide

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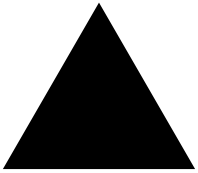

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Preface

This Preface provides an overview of this guide, describes guide conventions, and lists other publications that may be useful.

Introduction

This guide provides the required information to install the PoS module in a BlackDiamond® 6800 series switch from Extreme Networks and perform the initial module configuration tasks.

This guide is intended for use by network administrators who are responsible for installing and setting up network equipment. It assumes a basic working knowledge of:

- Local area networks (LANs).
- Ethernet concepts.
- Ethernet switching and bridging concepts.
- Routing concepts.
- Internet Protocol (IP) concepts.
- Routing Information Protocol (RIP) and Open Shortest Path First (OSPF).
- Simple Network Management Protocol (SNMP).

If the information in the release notes shipped with your module differs from the information in this guide, follow the release notes.

Terminology

When features, functionality, or operation is specific to one of the PoS modules, the specific module name is used. Explanations about features and operations that are the same across all of the PoS modules simply refer to the product as the "module."

Switches and switch modules that use naming conventions ending in "*i*" have additional capabilities that are documented throughout this user guide. For the most current list of products supporting the "*i*" chipset, consult your release notes.

Unless otherwise specified, a feature requiring the "*i*" chipset requires the use of both an "*i*" chipset-based management module, such as the MSM64i, and an "*i*" chipset-based I/O module, such as the G8Xi.

Conventions

Table 1 and Table 2 list conventions that are used throughout this guide.

Table 1: Notice Icons

Icon	Notice Type	Alerts you to...
	Note	Important features or instructions.
	Caution	Risk of personal injury, system damage, or loss of data.
	Warning	Risk of severe personal injury.

Table 2: Text Conventions

Convention	Description
`Screen displays`	This typeface indicates command syntax, or represents information as it appears on the screen.
`Screen displays bold`	This typeface indicates how you would type a particular command.
The words “enter” and “type”	When you see the word “enter” in this guide, you must type something, and then press the Return or Enter key. Do not press the Return or Enter key when an instruction simply says “type.”
[Key] names	Key names are written with brackets, such as [Return] or [Esc].
	If you must press two or more keys simultaneously, the key names are linked with a plus sign (+). Example:
	Press [Ctrl]+[Alt]+[Del].
Words in *italicized* type	Italics emphasize a point or denote new terms at the place where they are defined in the text.

Related Publications

The publications related to this one are:

- ExtremeWare™ release notes
- *ExtremeWare Software User Guide*
- *BlackDiamond 6800 Series Switch Hardware Installation Guide*
- *BlackDiamond Module Installation Note*

Documentation for Extreme Networks products is available on the World Wide Web at the following location:

http://www.extremenetworks.com/

1 Overview

The Packet over SONET (PoS) modules are I/O modules for the BlackDiamond 6800 series chassis-based system. These modules connect a BlackDiamond 6800 series switch to the SONET infrastructure used by metropolitan area service providers and operators of server co-location networks.

This chapter includes information on the following topics:

- BlackDiamond 6800 Series Switch Overview on page 1-1
- About the PoS Modules on page 1-3

BlackDiamond 6800 Series Switch Overview

The BlackDiamond 6800 series switch is a chassis-based switch designed to be placed in the core of your network. The BlackDiamond 6800 series switch is flexible and scalable, making it easy for you to meet the changing requirements of your network. The combination of BlackDiamond, Alpine™, and Summit™ switches delivers a consistent end-to-end network solution that provides a nonblocking architecture, wire-speed switching, wire-speed IP routing, and policy-based Quality of Service (QoS).

BlackDiamond I/O Modules

In addition to the PoS modules described in this guide, the BlackDiamond 6800 series switch supports a variety of I/O modules that offer a choice of port connections over different media types and distances. For more information, see the *BlackDiamond 6800 Series Switch Hardware Installation Guide*.

BlackDiamond 6800 series I/O modules can be inserted or removed at any time, without causing disruption of network services. No configuration information is stored on the I/O modules; all configuration information is stored on the MSM64i modules.

When the BlackDiamond 6800 series switch is powered on, the ExtremeWare software determines which slots are occupied by I/O modules, determines whether it has a configuration for each module, and generates a default configuration for each slot that is occupied by an I/O module that has not yet been configured. The default configuration is the minimal set of configuration parameter settings that will allow the I/O module and its ports to function. The default configuration for the I/O module is not preserved unless you explicitly save the information to nonvolatile RAM (NVRAM).

You can also use ExtremeWare commands to configure the I/O module after installing it in the BlackDiamond chassis, or you can preconfigure the parameters of a module that has not yet been inserted into the chassis.

If you preconfigure a slot for a particular module, the preconfigured information is used when the module is inserted. You must select a module type for the slot before you can preconfigure the parameters. If you have preconfigured a slot for a specific module type and then insert a different type of module, you must explicitly overwrite the existing configuration with a new configuration, or use the ExtremeWare `unconfig slot <slot>` command to clear the existing slot configuration. If you enter a new configuration for the new module, the module uses that configuration. If you clear the slot configuration, the new module type can use the default configuration ExtremeWare creates.

For information on configuring I/O modules, see the ExtremeWare Software User Guide*.*

About the PoS Modules

Two key applications for the PoS modules are: interconnecting metropolitan area networks across the SONET network infrastructure, and interconnecting server co-location network sites directly using SONET links.

In the first application, the metropolitan area network service provider can build service network sites in various cities, then use PoS modules in a BlackDiamond 6800 series switch to connect those cities to a carrier's SONET infrastructure.

In the second application, operators of server co-location networks can use PoS modules in BlackDiamond 6800 series switches to create a SONET-based connection between server co-location sites. The result is that their network is simpler to manage, and problems can be isolated and resolved more expediently.

Extreme Networks offers the PoS module in the following configurations:

- P3cMi: four OC-3 multimode, short-reach optical interfaces
- P3cSi: four OC-3 single-mode, intermediate-reach optical interfaces
- P12cMi: two OC-12 multimode, short-reach optical interfaces
- P12cSi: two OC-12 single-mode, intermediate-reach optical interfaces

The "c" in the names of the modules indicates that the optical interfaces on these modules operate in concatenated mode, which enables all the bandwidth to be devoted to a single payload stream.

The P3cMi (multimode version) operates in the 1310 nanometer (nm) wavelength window at a typical maximum cable distance of 2 kilometers (km) or 1.24 miles (mi). The P12cMi (multimode version) also operates in the 1310 nanometer (nm) wavelength, but at a typical maximum cable distance of 500 meters (m) or 0.31 (mi). The P3cSi and P12cSi (single-mode versions) also operate in the 1310 nanometer (nm) wavelength window, but at a typical maximum cable distance of 15 km or 9.32 (mi). All four versions of the PoS module use industry-standard duplex SC optical fiber connectors.

Physical Description

The PoS module consists of a printed circuit board mounted on a metal carrier that acts as the insertion vehicle in a BlackDiamond 6800 series switch (see Figure 1-1). The module carrier also includes ejector/injector handles and captive retaining screws at each end of the module front panel. The module occupies one slot in a BlackDiamond 6800 series switch.

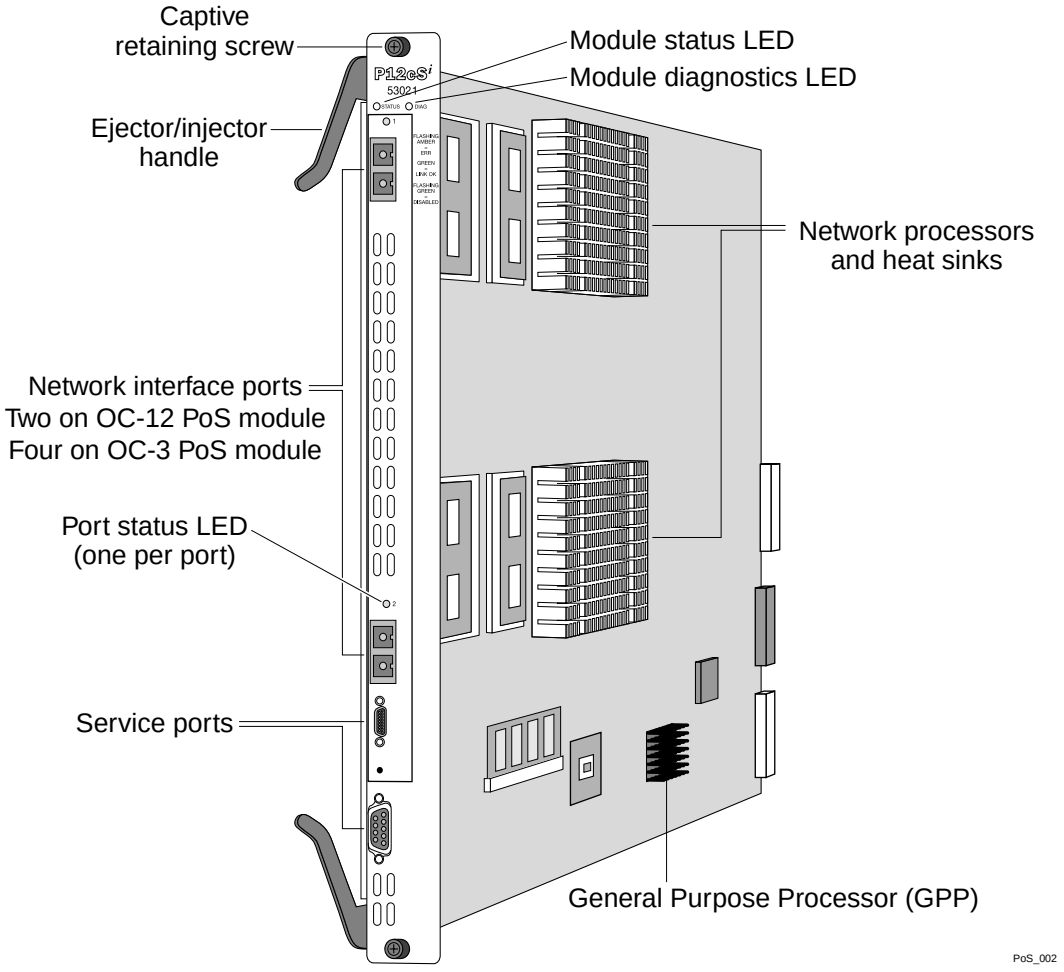


Figure 1-1: PoS module

The PoS module has the following key components:

- Two high-performance network processors
- A General Purpose Processor (GPP) subsystem

The network processors are programmable devices that participate with the Extreme "*i*" chipset to support expanded functionality, features, and flexibility.

The GPP subsystem handles system control and I/O module management functions. The GPP subsystem resides outside of the I/O module data path to optimize performance.

PoS Module LED Indicators

The PoS modules are equipped with two module-level LED indicators (STATUS and DIAG) and one port-level LED indicator for each network interface port on the PoS module (see Figure 1-2 and Figure 1-3).

The STATUS LED indicator is located near the top end of the PoS module front panel, near the ejector/injector handle. This LED indicator is a bi-color LED (displaying in either green or amber) that signals the operating status of the module as a whole.

The DIAG LED indicator is located beside the STATUS LED. This LED is a single-color LED (displaying in amber only) that flashes amber when diagnostics are running on the module, and is solid amber if the module fails the diagnostics.

The port-level LED is an LED next to the port number identifying each fiber optic network interface connector on the front panel of the module. The port LED is a bi-color LED (displaying in either green or amber) that signals the operating status of that network interface port.

For more information on PoS module LED states and their use in troubleshooting PoS module problems, see "Verifying the Module Installation" on page 2-10.

Service Ports

The PoS modules are equipped with two front-panel service ports: one port is a subminiature DB-9 connector; the other is a micro HD-15 connector (see Figure 1-1). Both ports are reserved for use only by Extreme Networks technical support personnel for diagnostic purposes.

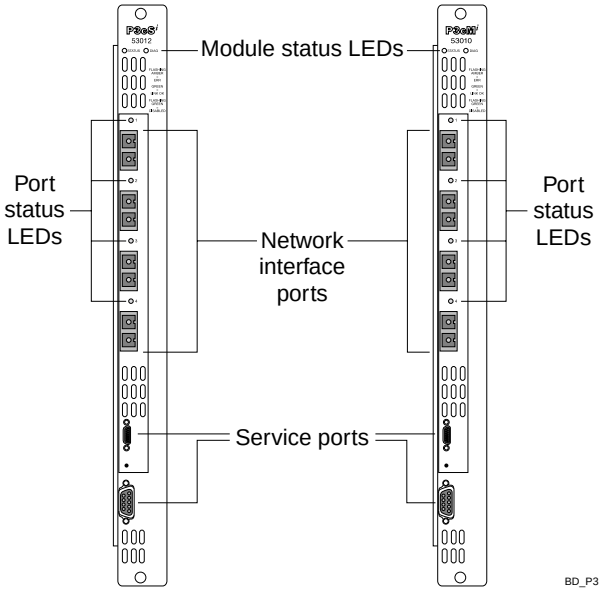


Figure 1-2: Front panel views of the P3cSi and P3cMi modules

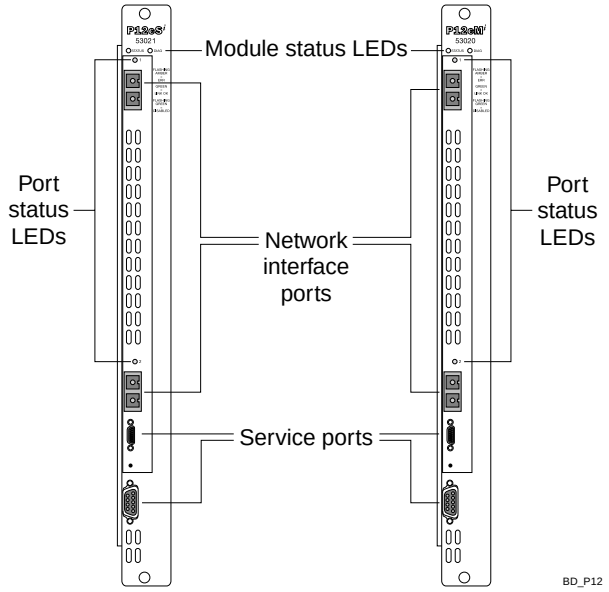


Figure 1-3: Front panel views of the P12cSi and P12cMi modules

Feature Summary

The PoS modules provide the following key networking functions:

- Support for both Synchronous Optical Network (SONET) and Synchronous Digital Hierarchy (SDH) modes of operation
- Support for the Point-to-Point Protocol (PPP) suite, including:
  - Link Control Protocol (LCP)
  - Link Maintenance option for LCP
  - Link Quality Report (LQR) Protocol
  - Password Authentication Protocol (PAP)
  - Challenge Handshake Authentication Protocol (CHAP)
  - IP Control Protocol (IPCP)
  - Bridging Control Protocol (BCP)
  - Extreme Discovery Protocol Control Protocol (EDPCP)

- Efficient support for IP routing over SONET via IPCP
- Support for Transparent LAN Services (TLS) over SONET via BCP
- Support for MultiProtocol Label Switching Control Protocol (MPLSCP) via PPP
- Support for jumbo frames
- Extensive support for Quality of Service (QoS) and Differentiated Services (DiffServ), including:
  - Eight ingress queues and eight egress queues per interface
  - Ingress and egress rate shaping and limiting
  - IEEE 802.1Q VLAN priorities
  - Weighted RED (WRED) congestion avoidance algorithm
  - Assured Forwarding and Expedited Forwarding RFCs
- Support for service provider specific features, such as:
  - Flexible remapping of DiffServ codepoints
  - Flexible remapping of IEEE 802.1Q VLAN IDs
  - VLAN tunneling via nested 802.1Q tags
  - Port tunneling of High-Level Data Link Control (HDLC) byte streams
- Support for NetFlow Version 1 per-flow statistics, including:
  - Capacity for two million flow records per PoS module
  - Scalability via distribution to groups of flow-record collector devices
  - Filters enabling statistics to be maintained for selected flows
  - Aggregation option for further reducing the volume of exported data
- Resiliency with fast recovery from SONET link failures via support for Automatic Protection Switching (APS) protocol in multiple configurations, including networks where the working and protection lines are:
  - Terminated in the same SONET module
  - Terminated in different SONET modules residing in the same BlackDiamond 6800 series system
  - Terminated in different SONET modules residing in different BlackDiamond 6800 series systems

Function Summary

The following sections provide brief descriptions of the key functions provided by the PoS modules. Each of these sections is expanded into greater detail in Chapter 3.

SONET and SDH

SONET and SDH are the two terms used to identify a time division multiplexing technology that is optimized for transporting voice traffic across a digital optical network, but that is also capable of providing high-speed capacity for transporting data.

The term SONET is used to identify the technology used within the North American digital network. Its standards are published by Bellcore and the American National Standards Institute (ANSI). The term SDH is used to identify the equivalent standard approved by the International Telecommunication Union (ITU) for use in Europe and elsewhere in the global digital network. Because SDH evolved out of SONET, the two standards are closely joined and have been widely accepted as a dominant choice for implementations requiring high transport capacity and resistance to failure.

PPP

PPP encompasses a suite of protocols designed to provide standard methods for transporting datagrams over point-to-point links. The use of PPP over SONET links is commonly referred to as Packet over SONET, or PoS. The Extreme Networks implementation of PPP for the PoS module provides support for the following protocols in the PPP suite:

- Link Control Protocol (LCP)
- Link Quality Report (LQR) Protocol
- Challenge Handshake Authentication Protocol (CHAP)
- Password Authentication Protocol (PAP)
- IP Control Protocol (IPCP)
- Bridging Control Protocol (BCP)
- Extreme Discovery Protocol Control Protocol (EDPCP)

MPLS

The PoS module ports provide MPLS support via a PPP link. The MPLS Control Protocol (MPLSCP) allows MPLS labeled packets to be transported across a PPP link.

MPLS labeled packets can also be encapsulated in Ethernet headers and transported across a PPP link using BCP.

Jumbo Frames

The PoS module ports provide jumbo frame support that is similar to that provided by Ethernet ports on a BlackDiamond 6800 series switch.

Jumbo frames are Ethernet frames that are larger than 1522 bytes, including four bytes used for the cyclic redundancy check (CRC). Extreme products that use the "*i*" chipset support switching and routing of jumbo frames at wire-speed on all ports.

Jumbo frames are used between endstations that support larger frame sizes for more efficient transfers of bulk data. Both endstations involved in the transfer must be capable of supporting jumbo frames.

QoS and Differentiated Services

The PoS modules support eight ingress queues and eight egress queues per port. The scheduling parameters for these queues (minimum bandwidth, maximum bandwidth, priority level, etc.) are controlled by QoS profiles that you can customize for individual ingress or egress queues on a specific PoS port.

You can assign frames to queues based on IEEE 802.1p priorities, MPLS EXP values, Differentiated Services Code Points (DSCPs), or by configuring a QoS profile for the port or VLAN. You can tailor the DSCP-to-queue mapping for ingress or egress directions on a per-port basis. Most of the existing ingress classification functions, along with the DiffServ replacement functions, are also supported for PoS ports.

The supported DiffServ functions maximize user flexibility while providing all of the features needed to support the standard per-hop behaviors (PHBs), including:

- Default
- Class Selector
- Assured Forwarding
- Expedited Forwarding

The PoS modules also provide flexible support for the well-known Weighted RED (WRED) congestion avoidance algorithm.

Service Provider Features

The PoS modules provide the following features for service provider environments:

- DSCP mapping
- VLAN ID (VID) tag mapping
- VLAN ID (VID) tag nesting
- Port tunneling

You can use the `diffserv dscp-mapping` command to configure a mapped relationship between an input DSCP and an associated output DSCP. Each PoS port supports three DSCP mapping tables: one of the tables is used in the ingress direction; two are used for egress flows (onto the SONET link). The two egress tables are for the congested and noncongested states, as determined by the RED algorithm. If RED is not enabled on the PoS port, the egress congested-state mapping table is not used.

In the ingress direction, the input DSCP of a packet received from the SONET link is replaced by an output DSCP before the packet is forwarded. In the egress direction, the operation is similar, except that the DSCP mapping occurs before the packet is transmitted onto the SONET link.

One potential use of the DSCP mapping capability is to reconcile varying DiffServ policies at the boundary between autonomous systems, such as at the boundary between two ISPs. The availability of different tables for the congested and noncongested states is useful in marking operations that increase the probability of packets being dropped during times of congestion, as discussed in the DiffServ Assured Forwarding RFC (RFC 2597).

An analogous feature has been added for managing 802.1Q tags. The `dot1q tagmapping` command provides support for VLAN ID (VID) mapping tables. Each PoS port supports two VID tables: one table is used in the ingress direction; the other is used in the egress direction. Each of the tables enables an input VID to be mapped to an output VID. This feature is useful in reconciling policy differences at the boundary between the customer and the service provider.

Another related enhancement provides support for nested 802.1Q tags by allowing a *tag push* or *tag pop* attribute to be associated with a VID. The *push* attribute indicates that a new tag is to be added to the frame, while the *pop* attribute indicates that the top-level tag is to be removed from the frame. This capability is augmented by an option that allows the 802.1p priority of the frame to be either preserved or set to a user-configurable value when a new tag is pushed. These functions make it possible for service providers to tunnel customer-specific VLANs across a common SONET backbone in a very simple manner.

The PoS module also supports port tunneling. Port tunneling can be used to encapsulate and transport the raw High-Level Data Link Control (HDLC) encapsulated byte stream from one PoS port to another PoS port across an MPLS network. This allows service providers to tunnel different types of SONET HDLC streams across a non-SONET backbone like Ethernet.

NetFlow Statistics

Each PoS port can maintain and export statistics for the flows that traverse the associated SONET link.

Per-flow statistics are useful for many management purposes, including:

- Accounting and billing
- Network capacity planning and trend analysis
- Network monitoring
- Workload characterization
- User profiling
- Data warehousing and mining

Each PoS module can maintain two million flow records. Per-flow statistics are reported in the NetFlow, Version 1 format, which groups flow records together into UDP datagrams for export to a flow-collector device.

The PoS module also provides a NetFlow distribution feature to provide a growth path to more scalable and robust collection architectures. This feature allows a single PoS port to distribute statistics across multiple groups of flow-collector devices in a load-balanced manner. The function also includes a health-check feature that significantly improves the reliability of the collection architecture. The health-checker ensures that only responsive flow-collector devices are included in the effective export distribution lists.

To further enhance scalability, the PoS module also offers filters and filter-based aggregation options that allow you to configure a PoS port to maintain statistics selectively for only those flows matching specified filters. The aggregation options can further reduce the volume of exported data by enabling a single set of statistics to be maintained for all the flows that match an aggregation filter.

Automatic Protection Switching

Automatic Protection Switching, or APS, is a physical-layer resiliency feature specified in the SONET standards. Multiplex Section Protection, or MSP, is the APS equivalent in the SDH standard, which is also supported by the PoS module. Throughout this guide, the terms *APS* and *Automatic Protection Switching* are used to refer to the protection switching features of both standards.

Of the various protection switching modes specified in the SONET/SDH standards, the BlackDiamond 6800 series switches use the linear 1+1 architecture to protect tributary SONET lines. In the linear 1+1 architecture, there is one protection line for each working line. If the working line fails, traffic is automatically switched to the protection line. You can also control whether traffic switched to the protection line is automatically switched back to the working line when it is restored to service.

The Extreme Networks implementation supports network configurations where:

- Working and protection lines are terminated in the same PoS module.
- Working and protection lines are terminated in different PoS modules residing in the same BlackDiamond 6800 series switch.
- Working and protection lines are terminated in different PoS modules residing in different BlackDiamond 6800 series switches.

2 Installing or Replacing a PoS Module

This chapter includes information on the following topics:

- Preparing for Installation on page 2-1
- Inserting and Securing a Module on page 2-7
- Making Network Interface Cable Connections on page 2-9
- Verifying the Module Installation on page 2-10
- Troubleshooting on page 2-11
- Removing and Replacing an I/O Module on page 2-16

Preparing for Installation

This section describes the preparation steps that you must perform before inserting and securing a PoS module. This section includes information on the following topics:

- Software and Hardware Version Requirements on page 2-2
- Cables and Connectors on page 2-3
- Safety Information on page 2-4
- Tools on page 2-5
- I/O Module Slot Locations on page 2-5

Software and Hardware Version Requirements

The PoS modules are compatible with "*i*"-series MSM modules only, but are compatible with both Summit and "*i*"-series I/O modules. For the most current list of I/O modules supported for use with the PoS modules, consult your release notes.

Software support for PoS modules is provided in an ExtremeWare *technology release*, which is a software release providing specialized hardware support and/or additional functionality not found in the current mainstream ExtremeWare release.

The ExtremeWare technology release that supports PoS modules includes multiple software packages. One software package runs on the MSM module, while another package runs on each PoS module. These software packages are downloaded independently using the ExtremeWare `download image` command. Each software package has an associated version number that you can display by using the `show version` command. As a recommendation (not a requirement), the MSM software package and the PoS module software package should be the same version. To ensure compatibility, the MSM performs an automatic compatibility check before a PoS module is activated. In case of incompatibility, the PoS ports on the module will not come up and the `show slot` command will indicate that the software on the PoS module is incompatible with the software on the MSM.

You can also verify compatibility by comparing the version of the MSM software package with the version of the PoS module software package. The format of the software version field of the ExtremeWare software version identifier has been extended to support technology releases. The following example of the ExtremeWare software version identifier illustrates the extended version format:

ExtremeWare V6.1.5 (Build 20) Project IP_SERV_TECH_REL V1.2.64

In this example, the technology release-specific version information *Project IP_SERV_TECH_REL V1.2.64* is added to the base ExtremeWare version identifier *ExtremeWare V6.1.5 (Build 20)* to form the extended version identifier format. The first field of the version identifier, *ExtremeWare V6.1.5 (Build 20)*, identifies the ExtremeWare software version on which this technology release is based. The second field in the extended version identifier, *Project IP_SERV_TECH_REL*, is the name of the technology release. The final field, *V1.2.64* is a three-part number that identifies the version of the technology release. In the example, the first part of the number, *1*, is the *extended major* version number; the second part of the number, *2*, is the *extended minor* version number; the third part of the number, *24*, is the *extended build* version number.

The MSM software package is compatible with the PoS module software package when the following conditions are true:

- Base ExtremeWare version numbers match
- Technology release names match
- Extended major version numbers match
- Extended minor version number of the MSM software package is equal to or greater than the extended minor version of the PoS module software package

The extended build number is ignored for compatibility comparisons.

For example, MSM software package *ExtremeWare V6.1.5 (Build 20) Project IP_SERV_TECH_REL V1.2.64* is compatible with PoS module software package *ExtremeWare V6.1.5 (Build 20) Project IP_SERV_TECH_REL V1.1.98*, but is not compatible with PoS module software package *ExtremeWare V6.1.5 (Build 20) Project IP_SERV_TECH_REL V2.1.1*.

Cables and Connectors

Extreme Networks offers the PoS module in the following configurations:

- P3cMi: four OC-3 multimode, short-reach optical interfaces
- P3cSi: four OC-3 single-mode, intermediate-reach optical interfaces
- P12cMi: two OC-12 multimode, short-reach optical interfaces
- P12cSi: two OC-12 single-mode, intermediate-reach optical interfaces

The "c" in the names of the modules indicates that the optical interfaces on these modules operate in concatenated mode, which enables all the bandwidth to be devoted to a single payload stream.

The P3cMi (multimode version) operates in the 1310 nanometer (nm) wavelength window at a typical maximum cable distance of 2 kilometers (km) or 1.24 miles (mi). The P12cMi (multimode version) also operates in the 1310 nanometer (nm) wavelength, but at a typical maximum cable distance of 500 meters (m) or 0.31 (mi). The P3cSi and P12cSi (single-mode versions) also operate in the 1310 nanometer (nm) wavelength window, but at a typical maximum cable distance of 15 km or 9.32 (mi). All four versions of the PoS module use industry-standard duplex SC optical-fiber connectors.

Use the appropriate type of optical-fiber cable—single-mode or multimode—to connect the PoS ports of your BlackDiamond 6800 series switch to another switch or router.

Single-mode and multimode optical-fiber cables can be acquired from a number of different cable vendors, including AMP, Anixter, AT&T, Red-Hawk, and Siemens.

Safety Information

Before you begin the process of installing or replacing a PoS module in a BlackDiamond 6800 series system, read the safety information in this section.

Failure to observe the necessary safety guidelines can lead to personal injury or damage to the equipment.

In addition, observe the following safety guidelines:

- All service to components of a BlackDiamond 6800 series switch, including I/O modules, should be performed by trained service personnel only. Service personnel are persons having appropriate technical training and experience necessary to be aware of the hazards to which they are exposed in performing a task and of measures to minimize the danger to themselves or other persons.

  The PoS modules use electronic components that are sensitive to static electricity. Electrostatic discharge (ESD) originating from you or from objects around you can damage these components. Exercise every possible precaution to prevent ESD when working around printed circuit assemblies.

  Keep all printed circuit assemblies in protective ESD-preventive sacks or place them on antistatic mats until you are ready to install them. Wear an ESD-preventive wrist strap and ensure that the leash is securely grounded before handling a bare printed circuit assembly.

- This device contains fiber optic ports. To protect your eyes, you should never look at the fiber optic ports while they are on, or look directly at the fiber cable ends when they are on.
- This module is a Class 1 laser device.

Tools

You need the following tools to install an Extreme Networks I/O module in a BlackDiamond 6800 series chassis.

- ESD-preventive wrist strap and grounding leash that is provided with the BlackDiamond 6800 series chassis.
- Number 1 Phillips-head screwdriver.
- Optical-fiber cable of the type appropriate to the I/O module version you plan to install (see "Cables and Connectors" on page 2-3 for more information about cable and connector requirements).

I/O Module Slot Locations

Figure 2-1 shows the I/O module slot locations in the BlackDiamond 6800 series chassis. You can install the PoS module in any of the numbered slots labeled slots 1 through 8. I/O modules do not fit in slots A or B. When you are installing a new PoS module, you must first remove the blank filler from the available slot.

To ensure a sufficient flow of cooling air across the component side of the PoS module, install the PoS module in the BlackDiamond 6800 series chassis so that another module, a blank filler, or the far right chassis wall covers the component side of the module.

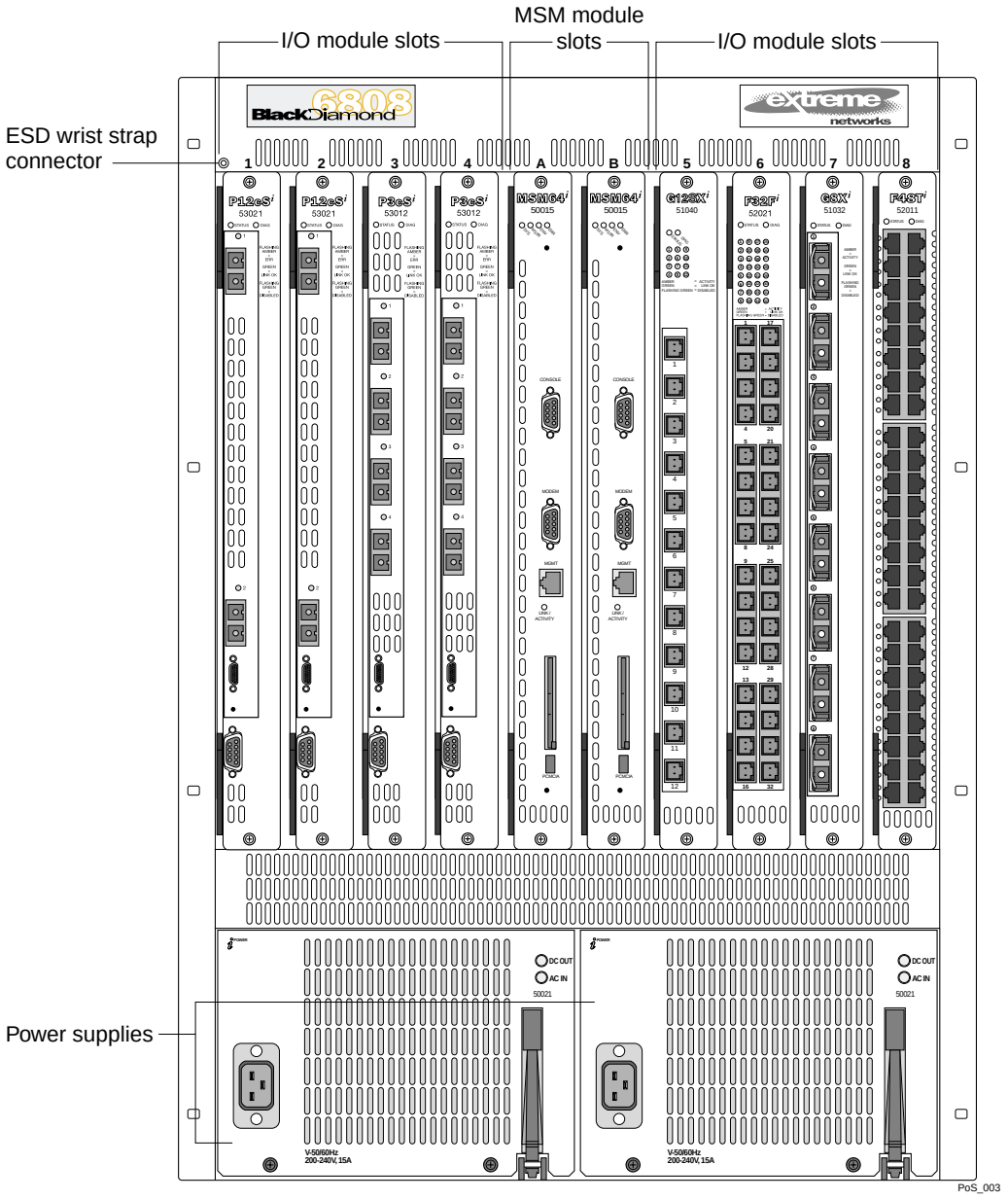


Figure 2-1: Slot locations in a BlackDiamond 6800 series chassis

Inserting and Securing a Module

This section describes the procedures for inserting and securing a PoS module.

Caution: I/O modules must be installed in any of the numbered chassis slots labeled slots 1 through 8. I/O modules do not fit in slots A or B. Forceful insertion can damage the I/O module.

1 Before you install modular cards in the BlackDiamond 6800 series chassis, put on the ESD-preventive wrist strap that is provided with the chassis, and connect the metal end of the grounding leash to the ground receptacle located on the top-left corner of the BlackDiamond 6800 series switch front panel.

Leave the ESD-preventive wrist strap permanently connected to the BlackDiamond 6800 series chassis so that it is always available when you need to handle ESD-sensitive switch components.

2 Identify the chassis slot for the module. If necessary, remove the blank filler from the slot to make room for the PoS module.

Any unoccupied module slot in the chassis should have a blank filler installed for electromagnetic compatibility (EMC) and to ensure adequate airflow through the chassis.

3 To insert a PoS module, use Figure 2-2 as a reference and follow these steps:

To prevent ESD damage, handle the PoS module by the metal card carrier edges only. Never touch components on the printed circuit board or pins on any of the connectors. Never attempt to lift or hold the module by using the heat sinks on either of the network processors.

a Grasp the module by its front panel with one hand and place your other hand under the edge of the metal card carrier to support the weight of the module.

b Ensure that the module is right side up (printed circuit board, or PCB, facing to the right) and that the ejector/injector handles are fully extended.

c Carefully align the upper and lower edges of the metal card carrier in the chassis slot and slide the module slowly into the slot, taking particular care that the heat sinks on the two network processors are not obstructed in any way.

d Continue sliding the module into the chassis slot until the ejector/injector handles make contact with the front edges of the chassis slot, then stop.

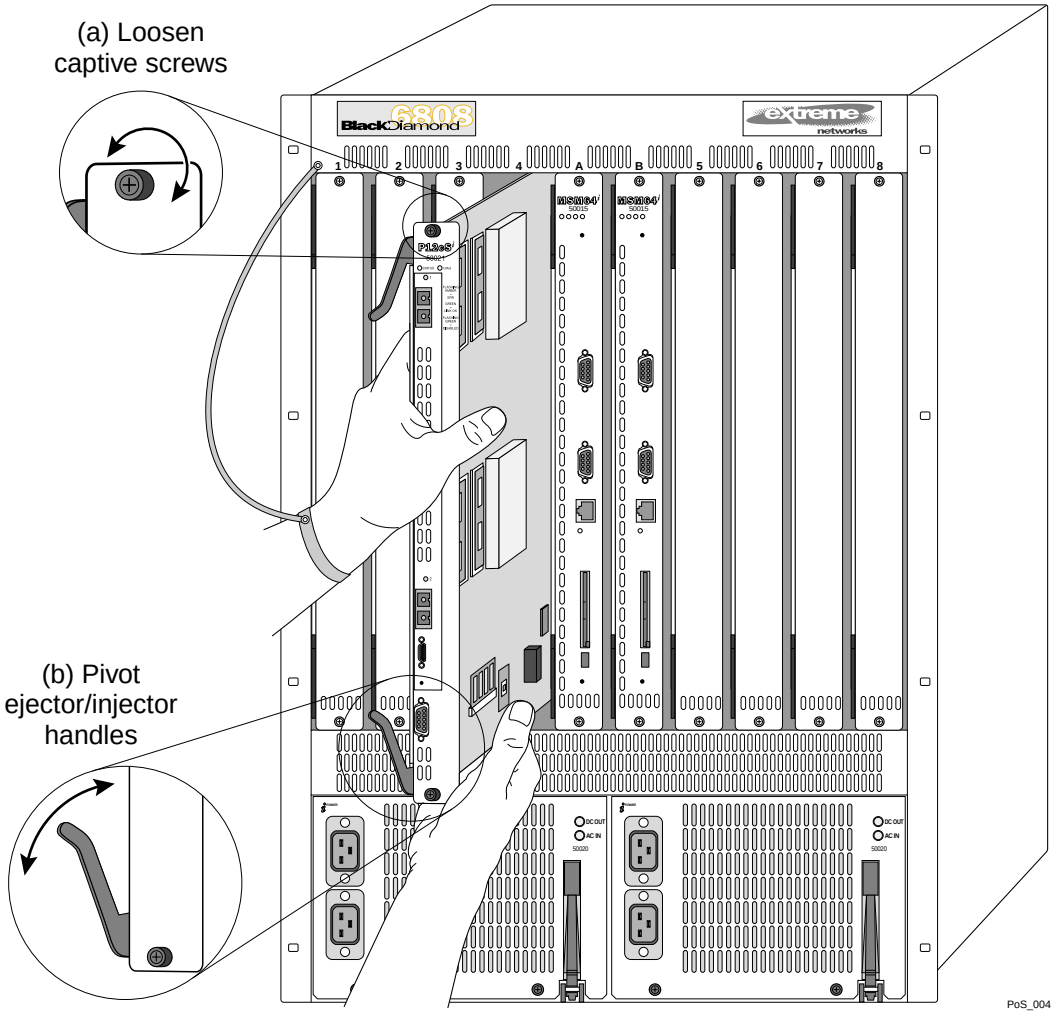


Figure 2-2: Inserting and securing a PoS module

When the module is pushed into the chassis slot, the ejector/injector handles will begin pivoting to their closed position.

e To seat the module in the backplane connectors, completely close the module ejector/injector handles by pushing them toward the center of the module front panel.

f Use a #1 Phillips-head screwdriver to tighten the captive screw on each end of the module front panel to prevent the module from being dislodged from the backplane connectors and to ensure satisfactory protection from EMI.

Repeat this procedure for additional modules, if applicable.

Making Network Interface Cable Connections

Use the appropriate type of optical-fiber cable—single-mode or multimode—to connect the PoS ports of your BlackDiamond 6800 series switch to another switch or router.

Kinks and sharp bends can destroy or impair the cable's ability to convey light pulses accurately from one end of the cable to the other. Use care in dressing the optical-fiber cables: provide satisfactory strain relief to support the cable and maintain an adequate bend radius at all cable turns, particularly where the cable connects to the I/O module.

Working carefully, one port at a time, follow these steps:

1 Verify that you have identified the correct optical-fiber cable for the PoS module port.

2 Use an alcohol wipe or other appropriate cleaning agent to clean the fiber element on the cable connectors to be sure they are free of dust, oil, and other contaminants.

3 Align the transmit (Tx) and receive (Rx) connectors on the optical-fiber cable with the correct corresponding connectors on the PoS module.

On the PoS modules, the transmit (Tx) connector on each port is the top connector.

4 Press the cable connectors into their mating connectors on the PoS module until the cable connector is firmly seated.

5 Repeat steps 1 through 4 for the remaining cables on this or other PoS modules.

6 Dress and secure the cable bundle to provide appropriate strain relief and protection against bends and kinks.

Verifying the Module Installation

After you have installed the PoS module and connected the fiber optic cables, verify that the I/O module is working correctly. Check the LEDs on the front panel of the I/O module and use the command-line interface (CLI) `show slot <slot>` command to display slot-specific information about the newly installed module.

LED Indicators

When the PoS module and its ports are configured and operating normally, the front-panel LED indicators should appear as follows:

- STATUS LED indicator: flashing green
- DIAG LED indicator: off
- Port status LED indicators (per port):
  - Green: The link is operational.
  - Green blinking: The link is disabled.
  - Amber blinking, returning to green: There is activity on the link.
  - Amber blinking: The link is down (SONET error).
  - Off: No signal was received.

Displayed Slot Status Information

Assuming that there are no other problems with the PoS module, the command `show slot n` (where *n* is the number of the slot where you installed the module) will show that ExtremeWare has detected the module and set it to the OPERATIONAL state.

As the module progresses through its initialization, the `show slot n` command will show the GPP subsystem change state to OPERATIONAL, and then each of the network processors will change state to OPERATIONAL.

When the GPP subsystem has completed its initialization cycle and the subsystem state is OPERATIONAL, you can use the `show diagnostics {<slot>}` *command to check the results of the module's power-on self test (POST).*

Troubleshooting

This section describes how to isolate module-specific problems and determine when it is appropriate to remove and replace a PoS module. This section includes information on the following topics:

- Identifying Problem Categories on page 2-12
- Fixing Configuration Errors on page 2-13
- Upgrading the Switch Software Image on page 2-14
- Upgrading the PoS Module Software Image on page 2-14
- Fixing Power-Related Problems on page 2-15
- Fixing Link Down Problems on page 2-15
- Identifying Conditions for Replacing an I/O Module on page 2-16

The information in this section should be used in conjunction with the "Troubleshooting" appendix in the ExtremeWare Software User Guide *and the release notes that accompanied your Extreme Networks product. If you encounter a problem that is not discussed in one of these resources, contact Extreme Networks technical support.*

Identifying Problem Categories

Table 2-1 lists the color states of PoS module and port LEDs and describes their associated meanings. The STATUS and DIAG LEDs apply to the module as a whole; the port status LED for each port provides status information about that port.

Table 2-1: PoS Module and Port LEDs

LED	Color	Indicates	Corrective action
STATUS	Green blinking	Normal operation	(No action required.)
	Amber blinking	Configuration error (configured slot type is different than inserted module type)	See "Fixing Configuration Errors" on page 2-13.
		Version error (ExtremeWare version does not recognize inserted module)	See "Upgrading the Switch Software Image" on page 2-14.
		Version error (the PoS module image version is not compatible with the MSM image version)	See "Upgrading the PoS Module Software Image" on page 2-14.
		Hardware error (module failed diagnostics)	See "Identifying Conditions for Replacing an I/O Module" on page 2-16.
		Network processor or GPP down (as detected by network processor heartbeat protocol)	Reboot slot. If condition persists, run diagnostics.
	Off	No power	See "Fixing Power-Related Problems" on page 2-15.
DIAG	Amber blinking	Diagnostics in progress	(No action required.) When the LED goes off, use the `show diagnostics {<slot>}` command to see test status.
	Amber	Diagnostics failed	See "Identifying Conditions for Replacing an I/O Module" on page 2-16.
	Off	No diagnostics in progress	(No action required.)

Table 2-1: PoS Module and Port LEDs (continued)

LED	Color	Indicates	Corrective action
Port *x*	Green	Link up[1]	(No action required.)
	Green blinking	Link disabled	See “Fixing Link Down Problems” on page 2-15.
	Amber blinking, returning to green	Activity on link	(No action required.)
	Amber blinking	Link down; SONET link problem	See “Fixing Link Down Problems” on page 2-15.
	Off	No received signal	See “Fixing Link Down Problems” on page 2-15.

1. The link is up, but the PPP/VLAN interface might not be up. To determine whether PPP is up, use the `show ppp` command to display PPP status information (see the command description on page 3-27).

Fixing Configuration Errors

If the STATUS LED on the PoS module turns amber and blinks, use the `show slot` command to display the configured slot type. The output from this command also displays information about the module state, including the CARD MISMATCH message. This message indicates that the slot was previously configured for a module type different than the one you just installed.

Use one of the following commands to reset the slot configuration:

- `clear slot <slot>`
- `unconfig slot <slot>`
- `config slot <slot> module [f32t | f32f | f48t | g4x | g6x | g8x | g12x | p3c | p12c]`

The first two commands listed above clear the slot of a previously assigned module type. The third command replaces the existing module type configuration with a new module type configuration.

Upgrading the Switch Software Image

If the STATUS LED on the PoS module turns amber and blinks, use the `show slot` command to display the configured slot type. The output from this command also displays information about the module state, including the CARD UNKNOWN message. This message indicates that the installed ExtremeWare software image version does not recognize the module type.

To correct this problem, you will need to upgrade the ExtremeWare software image. To perform this task, see the "Software Upgrade and Boot Options" chapter in the *ExtremeWare Software User Guide.*

Upgrading the PoS Module Software Image

The PoS module software image file contains the executable code that runs on the PoS module. The image file is preinstalled on the PoS module at the factory. As new versions of the image are released, they can be downloaded to the PoS module.

When you upgrade the PoS module software image, you might also be required to upgrade the image for associated MSM modules to maintain software compatibility.

To download a PoS software image, use the following command:

```
download image [<ipaddress> | <hostname>] <filename> {primary | secondary}
   slot <slot>
```

This command is the same command used to download ExtremeWare images to MSM modules, but you use the `slot <slot>` option to download the specified image file to the PoS module in the specified slot rather than to one of the switch's image partitions.

Like the MSM module, the PoS module can store up to two images: a primary and a secondary image. When you download a new image, you must specify the image space—primary or secondary—where the new image is to be stored. If you do not specify the image space, the new image is downloaded to the image space that will be used as the load source on the next reboot.

To select which image—primary or secondary—the PoS module will load on the next reboot, use the following command:

```
use image [primary | secondary] slot <slot>
```

Fixing Power-Related Problems

If the LEDs on all other modules are off, verify that the BlackDiamond 6800 series switch is connected to an appropriate power source and is turned on.

If the LEDs on the new module are off, but the LEDs on other modules are on, try ejecting and reseating the unpowered module. If the module still does not power up, it is possible that the available system power is not sufficient to handle the power requirements of the added module. To test this condition, temporarily eject another I/O module to see whether that frees enough power to power up the new card. If it does, you may need to upgrade the power supply configuration in this BlackDiamond 6800 series switch. For more information on system power configuration, see the *BlackDiamond 6800 Series Switch Hardware Installation Guide*.

Fixing Link Down Problems

A flashing green port status LED can indicate the following conditions:

- Port is disabled.
- Port is not configured as a member of a VLAN.

To enable a port, use the following command:

```
enable ports <portlist>
```

To add a port to a VLAN, use the following command:

```
config vlan <name> add port <portlist> {tagged | untagged} {nobroadcast}
```

A flashing amber port status LED indicates that a signal has been detected, but that one or more SONET alarms exist. Use the `show sonet detail` command to display SONET status information.

If the port status LED is off, suspect a loss-of-signal condition caused by a optical-fiber cable or connector problem. Check for one or more of the following conditions:

- The transmit (Tx) and receive (Rx) cable connectors are reversed in the module port connector. Remove and reinsert the connectors in their correct positions.
- The optical-fiber cable is not terminated. Verify that the connectors on both ends of the cable are plugged in correctly and firmly seated.
- The optical-fiber cable is damaged. Replace the cable with a cable known to be good and try again.

Identifying Conditions for Replacing an I/O Module

If the STATUS LED on the PoS module turns amber and blinks, use the `show slot` command to display the slot status information. If the output of the command shows that the module state is not OPERATIONAL, use the following commands to run the diagnostics on the module and display the results:

```
run diagnostics [normal | extended] <slot>
show diagnostics {<slot>}
```

The displayed results list each test that was run, and indicate whether that test passed or failed. If the diagnostics fail, replace the PoS module with another module of the same type.

After you run the diagnostics, you must use the `reboot slot` *command to reset the slot and reload the operational PoS module software image.*

For more information about the slot diagnostics, see the "Status Monitoring and Statistics" chapter in the *ExtremeWare Software User Guide*.

Removing and Replacing an I/O Module

I/O modules can be installed only in any of the BlackDiamond 6800 series chassis slots labeled slots 1 through 8. I/O modules do not fit in slots A or B. Forceful insertion can damage the I/O module.

I/O modules can be extracted from the BlackDiamond 6800 series chassis, or inserted into the chassis at any time, without disrupting network services.

Tools and Equipment

You will need the following items to remove and replace an I/O module:

- ESD-preventive wrist strap and leash
- Number 1 Phillips-head screwdriver
- Replacement I/O module

Removing an I/O Module

To remove an I/O module, follow these steps:

1. Put on the ESD-preventive wrist strap that is provided with the chassis, and verify that the metal end of the leash is connected to the ground receptacle located on the top-left corner of the BlackDiamond 6800 series switch front panel.
2. Identify the I/O module to be replaced and write down the following information for later use:
   - The chassis slot number and the type of I/O module. When you install the replacement I/O module, install it in the same chassis slot.
   - The optical-fiber cable connections to the I/O module connectors. You must reconnect the cables to the same connectors on the replacement I/O module.
3. Disconnect all of the optical-fiber cables from the I/O module and set them carefully aside.

   Be very careful in handling optical-fiber cables: kinks and sharp bends can destroy or degrade the cable's ability to convey light pulses accurately.

4. Use the #1 Phillips-head screwdriver to loosen the captive screw at each end of the I/O module front panel.
5. Grasp both ejector/injector handles and pivot them simultaneously away from each other to unseat the module from the chassis backplane.
6. Use the ejector/injector handles to pull the module part way out of the chassis slot. Do not touch the printed circuit board or any connector pins.

   There is an EMI-preventive gasket attached to one edge of the module front panel. To prevent diminished EMI protection, handle the module carefully and avoid damage to this gasket.

7. Grasp the module front panel with one hand and place your other hand under the metal card carrier to support the weight of the module. Slide the module completely out of the chassis slot. Place the module immediately into an antistatic sack to protect it from ESD damage and prevent dust from collecting on the module's optical-fiber connectors.
8. Install and secure the replacement module as described in the "Inserting and Securing a Module" on page 2-7.
9. Check your notes on the slot assignment and cable connection information that you wrote down before removing the defective I/O module, then reconnect the network interface cables to their assigned ports on the I/O module.

3 Configuring the PoS Module

This chapter describes the ExtremeWare commands that support the PoS module. Other commands and background information used to configure I/O modules and switch behavior in a network are documented in the *ExtremeWare Software User Guide*. For hardware installation information on the BlackDiamond 6800 series switch, see the *BlackDiamond Hardware Installation Guide*.

Documentation for Extreme Networks products is available on the World Wide Web at the Extreme Networks home page at http://www.extremenetworks.com/.

This chapter includes information on the following topics:

- Basic PoS Module Configuration Information on page 3-2
- Configuring and Monitoring SONET Ports on page 3-12
- Configuring and Monitoring PPP Functions on page 3-22
- Configuring VLAN-Related Attributes on page 3-38
- Configuring Forwarding Database Attributes on page 3-42
- Configuring Spanning Tree Attributes on page 3-42
- Configuring QoS Functions on page 3-43
- Configuring and Monitoring Flow Statistics on page 3-60
- Configuring and Monitoring APS Functions on page 3-75
- Configuring Port Tunneling on page 3-97
- Additional PoS Module Support Topics on page 3-101

Basic PoS Module Configuration Information

This section uses several typical usage and configuration schemes to provide a brief overview of the PoS module configuration process as a general context for the detailed command description sections that follow.

Default PoS Module Configurations

When the BlackDiamond 6800 series switch is powered on, the ExtremeWare software determines which slots are occupied by I/O modules, determines whether it has a configuration for each module, and generates a default configuration for each slot that is occupied by an I/O module that has not yet been configured. The default configuration is the minimal set of configuration parameter settings that will allow the I/O module and its ports to function.

For the PoS modules, the default configuration depends on whether the module is an OC-3 module (P3cSi or P3cMi) or an OC-12 module (P12cSi or P12cMi). The OC-3 modules have some port-pairing considerations that affect configuration (see “PoS Port Configuration and Default VLAN Assignments” on page 3-3). In either case, the default configuration on the PoS module is for bridging (see “Default Configuration: Bridging Over PoS Ports” on page 3-3), with the Bridging Control Protocol (BCP) enabled, so that the module’s ports are brought up as members of the default VLAN and traffic is bridged between all ports in the VLAN. The default configuration includes values for the configurable SONET link parameters.

To perform routing over PoS ports using the IP Control Protocol (IPCP), or to take advantage of other features and capabilities, such as providing redundancy over the tributary links of the SONET network using Automatic Protection Switching (APS), you will need to perform additional configuration tasks. For examples of how to extend the configuration, see “Routing Over PoS Ports” on page 3-6 and “Automatic Protection Switching” on page 3-7.

PoS Port Configuration and Default VLAN Assignments

The ports on the PoS modules are identified by a port number that is a combination of the slot number where the module is installed and the port number on the module. The nomenclature for the port number is as follows:

```
slot:port
```

For example, you would refer to the four ports on an OC-3 PoS module installed in slot 4 of the BlackDiamond 6800 series chassis by the port numbers 4:1, 4:2, 4:3, and 4:4.

For more information about port numbers and port configuration, see the ExtremeWare Software User Guide*.*

Because the default Point-to-Point Protocol (PPP) network control protocol is the Bridge Control Protocol (BCP), all PoS ports are initially enabled for bridging. By default, only ports 1 and 3 on the OC-3 PoS modules are assigned to the default VLAN, while ports 2 and 4 are not assigned to a VLAN.

Because the first port pair on the OC-3 PoS modules (ports 1 and 2) and the second port pair (ports 3 and 4) use a common link to the switch backplane, ports belonging to the same port pair cannot be assigned to the same VLAN. The only exception to this rule is when APS is defined and one of the two ports of a port pair is used as the working line port, while the second port is used as the protection line port.

The port-pair restriction described above for the OC-3 PoS modules does not apply to the OC-12 PoS module.

Default Configuration: Bridging Over PoS Ports

The default configuration of the OC-3 PoS module enables you to connect either port 1 or 3 (not both) of an OC-3 PoS module in a BlackDiamond 6800 series switch to either port 1 or 3 of an OC-3 PoS module in a second BlackDiamond switch. In this configuration, all ports reside in the default VLAN and traffic is bridged between all ports in the VLAN. If you enable the Spanning Tree protocol, you can connect more ports in parallel, but they will be blocked for traffic transmission. Loadsharing is not supported over PoS links.

Configuration Commands for BCP

The bridged network example shown in Figure 3-1 does not require additional configuration commands for BCP support, because the default SONET and PPP

configuration values will bring up the ports as members of the default VLAN. However, the commands to enable BCP together with the default SONET values (see Table 3-1) are listed below for reference. The command `unconfig ppp ports <portlist>` will also reset these default values.

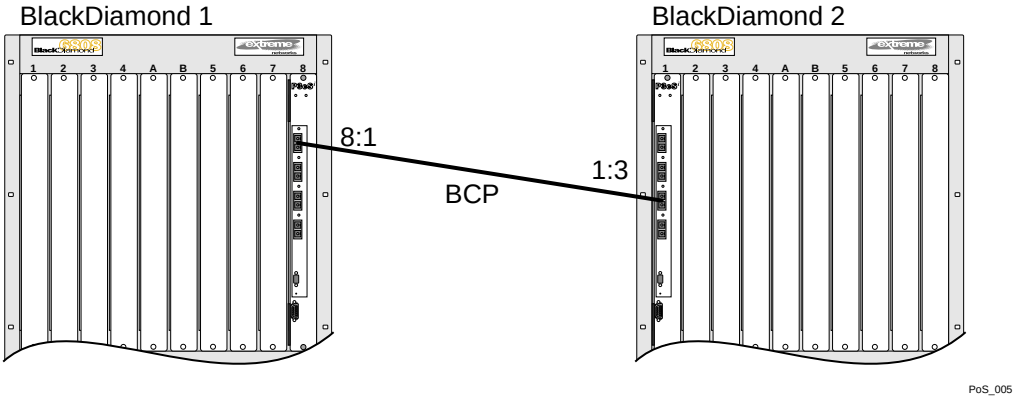


Figure 3-1: Default configuration for BCP

Configuring Default SONET and PPP Settings

The following configuration commands apply to the PoS module installed in slot 8 of BlackDiamond switch 1, as shown in Figure 3-1.

```
config ppp echo 1 5 ports 8:1
config ppp authentication off ports 8:1
config ppp quality off ports 8:1
config ppp user "extreme" encrypted "f7P*8aPO+86+'RL8E?MDZBJV`F)UC.-"
   ports 8:1
config ppp bcp on ports 8:1
config ppp ipcp off ports 8:1
config ppp pos checksum 32 ports 8:1
config ppp pos scrambling on ports 8:1
config ppp delayed-down-time 1 ports 8:1
```

Table 3-1 lists the configurable SONET link parameters and their default values.

Table 3-1: SONET Parameters and Values

Parameter	Possible Values	Default Value
Framing	SONET or SDH	SONET
Clock source	internal or line	internal
Signal Failure threshold[1]	10^{-3} through 10^{-5}	10^{-5}
Signal Degrade threshold[2]	10^{-5} through 10^{-9}	10^{-6}
J0 Section Trace byte[3]	0 through 255	1
J0 Section Trace string[4]	Maximum of 15 characters	15 NULL characters
J1 Path Trace identifier string[5]	Maximum of 64 characters	IP address of port's VLAN (in dotted-decimal notation)
C2 Signal Label[6]	0 through xFF	auto

1. B2 bit error rate (BER) threshold; a Signal Failure (SF) event is generated if the BER exceeds the specified threshold.
2. B2 bit error rate (BER) threshold; a Signal Degrade (SD) event is generated if the BER exceeds the specified threshold.
3. The default value of 1 is per ANSI T1.105-1995. This parameter applies only when SONET framing is configured on the port.
4. This parameter applies only when SDH framing is configured on the port.
5. When SDH framing is configured on the port, only the first 15 characters of the string are applied.
6. Set automatically based on synchronous payload envelope (SPE) payload type.

Routing Over PoS Ports

While you can configure BCP to perform routing over PoS ports, IPCP might be a better choice than BCP in those cases where the link will carry only routed IP traffic, because it provides a more efficient encapsulation scheme than does BCP, and thereby increases the maximum link throughput.

To take best advantage of the wire-speed layer 3 routing capabilities of the BlackDiamond 6800 series switch using the PoS module, configure IPCP as the PPP network control protocol to route between the PoS ports and any other VLANs. If you do not configure APS, an IPCP port must be the only port in a VLAN.

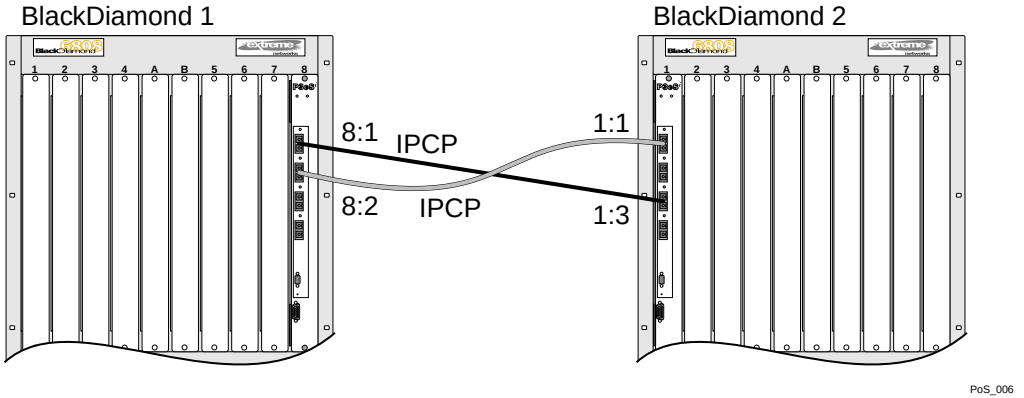


Figure 3-2: IPCP configuration

Configuration Commands for IPCP

For the IPCP routing network configuration example shown in Figure 3-2, the default configuration parameter settings for PoS ports should be suitable for most installations. Thus, only minimal additional configuration is needed to get IPCP up and running on a PoS port. The necessary configuration steps are:

1. Create a VLAN for each SONET port using the `create vlan <name>` command.
2. Add each SONET port to a VLAN using the `config vlan <name> add ports <port>` command.
3. Define an IP router port on each VLAN by assigning an IP address to each VLAN using the `config vlan <name> ipaddress <ipaddress> {<mask>}` command, and enable IF forwarding using the `enable ipforwarding` command.

4 Disable BCP on the SONET ports using the `config ppp bcp off ports <portlist>` command, and then enable IPCP on the SONET ports using the `config ppp ipcp on ports <portlist>` command.

The following configuration commands apply to the PoS module installed in slot 8 of BlackDiamond switch 1, as shown in Figure 3-2.

```
config ppp bcp off ports 8:1, 8:2
config ppp ipcp on ports 8:1, 8:2
create vlan vlanipcp1
create vlan vlanipcp2
config vlanipcp1 ipaddress 192.168.100.1 /30
config vlanipcp2 ipaddress 192.168.200.1 /30
enable ipforwarding
config vlanipcp1 add ports 8:1
config vlanipcp2 add ports 8:2
```

The following configuration commands apply to the PoS module installed in slot 1 of BlackDiamond switch 2, as shown in Figure 3-2.

```
config ppp bcp off ports 1:1, 1:3
config ppp ipcp on ports 1:1, 1:3
create vlan vlanipcp1
create vlan vlanipcp2
config vlanipcp1 ipaddress 192.168.100.2 /30
config vlanipcp2 ipaddress 192.168.200.2 /30
enable ipforwarding
config vlanipcp1 add ports 1:3
config vlanipcp2 add ports 1:1
```

Automatic Protection Switching

The ExtremeWare software APS implementation enables PoS links to provide redundancy over the tributary links of the SONET network. You can configure three levels of APS redundancy:

- Port redundancy (single PoS module configuration)
- Module redundancy (two PoS module configuration)
- Switch redundancy (two switch configuration)

These three APS redundancy options are described in the sections that follow. For more detailed information on the commands associated with APS, see “Configuring and Monitoring APS Functions” on page 3-75.

APS Port Redundancy

Figure 3-3 is an example of a single-module APS redundancy configuration, in which the working line and the protection line are terminated in the same PoS module in the BlackDiamond 6800 series switch. This configuration provides simple protection against line failures.

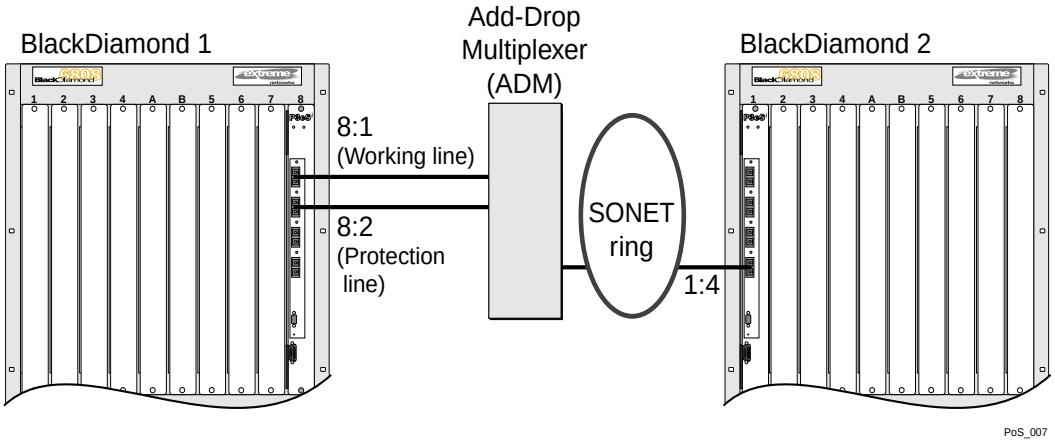


Figure 3-3: APS configuration, port redundancy

Configuration Commands for APS: Port Redundancy

The following configuration commands apply to the PoS module installed in slot 8 of BlackDiamond switch 1, as shown in Figure 3-3.

```
create vlan apslbvlan
config vlan apslbvlan ipaddress 192.168.1.1 /30
enable loopback-mode apslbvlan
create aps 1
config aps 1 add 8:1 working
config aps 1 add 8:2 protection 192.168.1.1
enable aps
```

APS Module Redundancy

Figure 3-4 is an example of a two-module APS redundancy configuration, in which the working line and the protection line are terminated in two different PoS modules in the same BlackDiamond 6800 series switch. This configuration provides simple protection against both line and module failures.

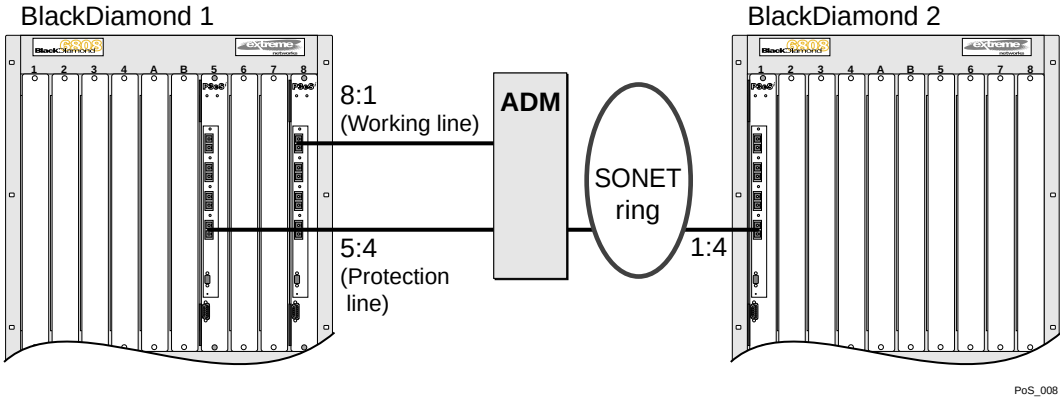


Figure 3-4: APS configuration, module redundancy

Configuration Commands for APS: Module Redundancy

The following configuration commands apply to the two PoS modules installed in slots 5 and 8 of BlackDiamond switch 1, as shown in Figure 3-4.

```
create vlan apslbvlan
config apslbvlan ipaddress 192.168.1.1 /30
enable loopback-mode apslbvlan
create aps 1
config aps 1 add 8:1 working
config aps 1 add 5:4 protection 192.168.1.1
enable aps
```

APS Switch Redundancy

Figure 3-5 is an example of a two-switch APS redundancy configuration, in which the working line is terminated in a PoS module in one BlackDiamond switch, while the protection line is terminated in a different PoS module in a different BlackDiamond switch. This configuration expands protection to include line, module, and switch failures.

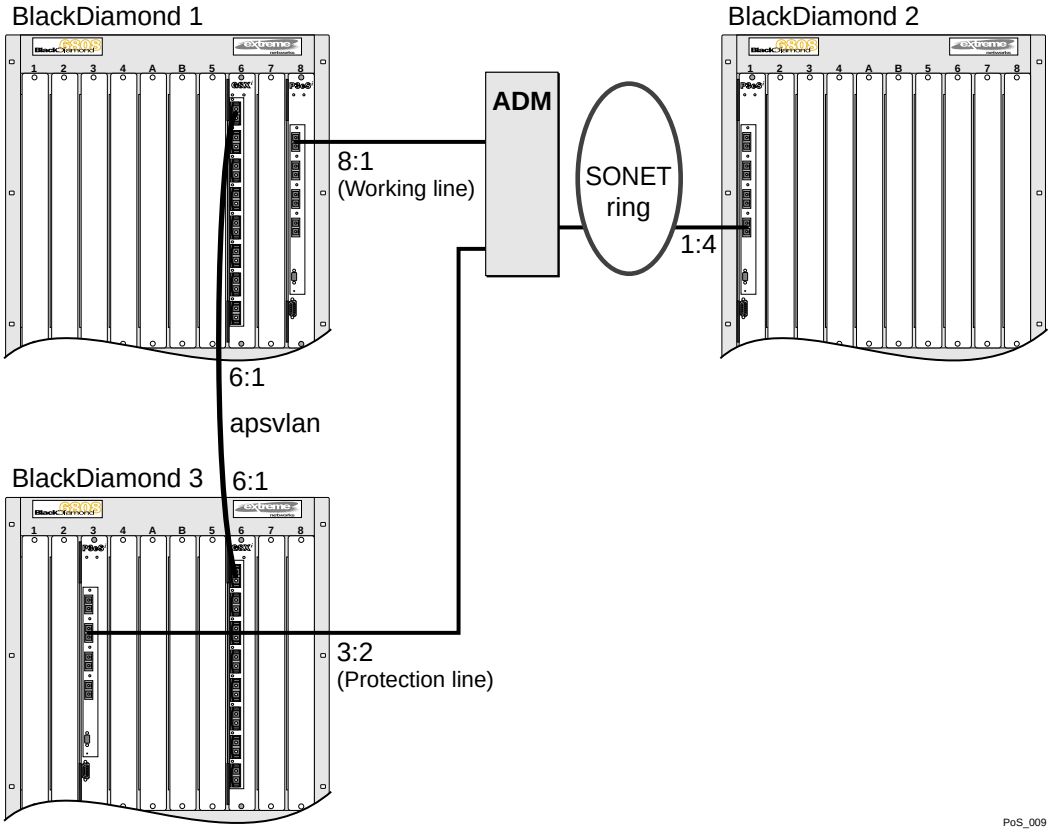


Figure 3-5: APS configuration for switch redundancy

Configuration Commands for APS: Switch Redundancy

The following configuration commands apply to the PoS module installed in slot 8 of BlackDiamond switch 1, as shown in Figure 3-5.

```
create vlan apsvlan
config apsvlan add port 6:1
config apsvlan ipaddress 192.168.1.1 /30
enable loopback-mode apsvlan
enable ipforwarding
create aps 1
configure aps 1 add 8:1 working
enable aps
```

The following configuration commands apply to the PoS module installed in slot 3 of BlackDiamond switch 3, as shown in Figure 3-5.

```
create vlan apsvlan
configure apsvlan add port 6:1
configure apsvlan ipaddress 192.168.1.2 /30
enable ipforwarding

create aps 1
configure aps 1 add 3:2 protection 192.168.1.1
enable aps
```

Configuring and Monitoring SONET Ports

In addition to the ExtremeWare commands for configuring slot and port behavior that are described in the *ExtremeWare Software User Guide*, this section describes the commands used to configure SONET link attributes.

This section provides information on the following topics:

- Commands for Configuring and Monitoring SONET Ports on page 3-13
- Configuring SONET Framing on page 3-13
- Configuring SONET Clocking on page 3-14
- Configuring the Signal Fail Threshold on page 3-14
- Configuring the Signal Degrade Threshold on page 3-15
- Configuring the Section Trace Identifier on page 3-15
- Configuring the Path Trace Identifier on page 3-16
- Configuring the Signal Label on page 3-17
- Resetting SONET Configuration Parameter Values on page 3-17
- Displaying SONET Port Status Information on page 3-18

Table 3-1 on page 3-5 describes the configurable SONET link parameters and their default values, Table 3-2 on page 3-13 describes the ExtremeWare commands for configuring and monitoring SONET ports, Table 3-3 on page 3-18 lists the supported SONET statistics, and Table 3-4 on page 3-19 describes the SONET events and their associated actions.

Commands for Configuring and Monitoring SONET Ports

Table 3-2 describes the ExtremeWare commands for configuring and monitoring SONET ports. Each command is described in detail in the sections that follow.

Table 3-2: SONET Port Commands

Command	Description
config sonet clocking [line | internal] ports <portlist>	Configures the clocking source for the specified SONET ports.
config sonet framing [sonet | sdh] ports <portlist>	Configures the framing type for the specified SONET ports.
config sonet signal label [auto | <hex_octet>] ports <portlist>	Configures the Signal Label value for the specified SONET ports.
config sonet threshold signal degrade <error_rate> ports <portlist>	Configures the Signal Degrade threshold for the specified SONET ports.
config sonet threshold signal fail <error_rate> ports <portlist>	Configures the Signal Failure threshold for the specified SONET ports.
config sonet trace path <id_string> ports <portlist>	Configures the Path Trace Identifier string for the specified SONET ports.
config sonet trace section [<id_byte> | string <id_string>] ports <portlist>	Configures the Section Trace Identifier for the specified SONET ports.
show sonet {<portlist>} {detail}	Displays SONET port status.
unconfig sonet ports <portlist>	Resets the configuration parameters of the specified SONET ports to their default values.

Configuring SONET Framing

You can configure each port for framing that complies with either the SONET standard or the SDH standard. SONET is primarily an American standard; SDH is the international version. The default is SONET.

To configure the framing for the specified SONET port, use the following command:

```
config sonet framing [sonet | sdh] ports <portlist>
```

The following command example selects SDH framing for port 1 of the PoS module installed in slot 8 of the BlackDiamond switch.

```
config sonet framing sdh ports 8:1
```

Configuring SONET Clocking

You can configure each port on the PoS module to use either line clocking, where the clock source is recovered from the received bit stream, or internal clocking, where the clock source is based on an internal clock. The default is internal.

To configure the clocking source for the specified SONET port, use the following command:

```
config sonet clocking [line | internal] ports <portlist>
```

The following command example selects line clocking for port 1 of the PoS module installed in slot 8 of the BlackDiamond switch.

```
config sonet clocking line ports 8:1
```

Configuring the Signal Fail Threshold

A Signal Failure (SF) event is generated if the bit error rate (BER) for the SONET line exceeds the configured threshold. An SF event brings the port down. If Automatic Protection Switching (APS) is enabled on the port, an SF event initiates a line switch.

To configure the Signal Fail threshold for the specified SONET port, use the following command:

```
config sonet threshold signal fail <error_rate> ports <portlist>
```

The `error_rate` parameter is an integer in the range from 3 to 5, where the SF BER is 10^{-error_rate}. The default value of the `error_rate` parameter is 5, which equates to an SF bit error rate of 10^{-5}, or 1 per hundred thousand.

The following command example sets the Signal Fail threshold value to 3 for port 1 of the PoS module installed in slot 8 of the BlackDiamond switch.

```
config sonet threshold signal fail 3 ports 8:1
```

You might set the signal fail threshold lower than the default value of 5 if your particular application has a very low tolerance for errors. In general, you should not change the default setting unless you are an expert and have a specific reason for the change.

Configuring the Signal Degrade Threshold

A Signal Degrade (SD) event is generated if the BER for the SONET line exceeds the configured Signal Degrade threshold. If APS is enabled on the port, an SD event initiates a line switch.

To configure the Signal Degrade threshold for the specified SONET port, use the following command:

```
config sonet threshold signal degrade <error_rate> ports <portlist>
```

The `error_rate` parameter is an integer in the range from 5 to 9, where the SD bit error rate is 10^{-error_rate}. The default value of the `error_rate` parameter is 6, which equates to an SD bit error rate of 10^{-6}, or 1 per million.

The following command example sets the Signal Degrade threshold value to 8 for port 1 of the PoS module installed in slot 8 of the BlackDiamond switch.

```
config sonet threshold signal degrade 8 ports 8:1
```

You might set the signal degrade threshold to a different value than the default value of 6 depending on your particular application's tolerance for errors. In general, you should not change the default setting unless you are an expert and have a specific reason for the change.

Configuring the Section Trace Identifier

Section trace is a maintenance feature of SONET. One byte of the Section Overhead associated with each SONET frame is used to carry information identifying the transmitting equipment.

To configure the Section Trace identifier for the specified SONET port, use the following command:

```
config sonet trace section [<id_byte> | string <id_string>] ports <portlist>
```

In this command, the Section Trace identifier can take one of two forms: an ID byte (`id_byte`) or an ID string (`id_string`).

The `id_byte` parameter is an integer in the range from 1 to 255, with a default value of 1. This parameter applies only when SONET framing is configured, in which case, the configured `id_byte` value is transmitted in each SONET frame.

The id_string parameter is a string of up to 15 characters. By default, the <id_string> parameter contains 15 NULL characters. This parameter applies only when SDH framing is configured, in which case the SDH framing cycles repetitively through a 15-character string, sending one character per frame. If the configured string contains fewer than 15 characters, it is padded to full length by NULL characters.

The following command example sets the Section Trace identifier to the string "1800wombat" for port 1 of the PoS module installed in slot 8 of the BlackDiamond switch.

```
config sonet trace section string 1800wombat ports 8:1
```

Configuring the Path Trace Identifier

Path trace is a maintenance feature of SONET. One byte of the Path Overhead associated with each SONET frame is used to carry information identifying the originating Path Terminating Equipment (PTE).

To configure the Path Trace identifier for the specified SONET port, use the following command:

```
config sonet trace path <id_string> ports <portlist>
```

The id_string parameter is a string of up to 64 characters. By default, the id_string parameter contains the IP address assigned to the VLAN to which the port belongs. This IP address is represented in dotted-decimal notation. If no IP address is assigned to the port's VLAN, the id_string parameter defaults to a string of 64 NULL characters.

When SONET framing is configured, a 64-character string is transmitted repetitively, one character per frame. If the configured string consists of fewer than 64 characters, it is padded to its full length with NULL characters.

When SDH framing is configured, the maximum length of the id_string parameter is 15 characters. If the configured string consists of more than 15 characters, it is truncated to 15 characters.

The following command example sets the Path Trace identifier to the string "parador" for port 1 of the PoS module installed in slot 8 of the BlackDiamond switch.

```
config sonet trace path parador ports 8:1
```

Configuring the Signal Label

The Signal Label field occupies one byte (C2) of the Path Overhead associated with each SONET frame. It is used to indicate the type of contents carried in the Synchronous Payload Envelope (SPE). For example, 0x16 indicates scrambled PPP / HDLC, while 0xCF indicates unscrambled PPP / HDLC.

To configure the C2 Signal Label value for the specified SONET port, use the following command:

```
config sonet signal label [auto | <hex_octet>] ports <portlist>
```

The `value` parameter is specified as a hexadecimal integer in the range from 00 to FF. It may be necessary to specify a particular Signal Label value in order to interoperate with implementations that do not follow the standard conventions for the Signal Label field.

To determine whether you need to specify a particular Signal Label value, perform the following tasks:

1. Use the `show sonet` command to display SONET port status information.
2. Look for a Path Payload Label Mismatch (PLM-P) event indicating that the received payload type does not match the expected payload.
3. Compare the contents of the received C2 field (Signal Label value) with the contents of the transmitted C2 field.

If no Signal Label value is specified, the command defaults to `auto`, which causes the value of the Signal Label field to be set automatically based on standard conventions for the given payload type.

The following command example sets the Signal Label to the hexadecimal value CF for port 1 of the PoS module installed in slot 8 of the BlackDiamond switch.

```
config sonet signal label CF ports 8:1
```

Resetting SONET Configuration Parameter Values

To reset the SONET configuration parameters for the specified SONET ports to their default values, use the following command:

```
unconfig sonet ports <portlist>
```

Displaying SONET Port Status Information

To display status information for the SONET ports, use the following command:

```
show sonet {<portlist>} {detail}
```

You can use the optional `portlist` parameter to narrow the range of status information the command displays; otherwise, the command displays the status information for all ports.

By default, the command displays a summary of status information for the specified ports. You can use the optional `detail` keyword to display detailed status information for the specified ports.

The summary of status information includes the following information for each port:

- Values of all port configuration parameters
- Port state
- Any active events

The detailed status information includes the summary information plus any SONET statistics (listed and described in Table 3-3).

Table 3-3: Summary of SONET Statistics

Statistic	Description
Section parity errors	Number of B1 parity errors detected
Line parity errors	Number of B2 parity errors detected
Path parity errors	Number of B3 parity errors detected
REI-L event counter	Number of B2 parity errors detected by peer LTE
REI-P event counter	Number of B3 parity errors detected by peer PTE
LOS event counter	Number of LOS events
LOF event counter	Number of LOF events
LOP event counter	Number of LOP events
AIS-L event counter	Number of AIS-L events
AIS-P event counter	Number of AIS-P events
RDI-L event counter	Number of RDI-L events
RDI-P event counter	Number of RDI-P events

Table 3-3: Summary of SONET Statistics (continued)

Statistic	Description
PLM-P event counter	Number of PLM-P events
SF BER event counter	Number of SF BER events
SD BER event counter	Number of SD BER events

SONET Events

The PoS module can detect and report a variety of error and alarm conditions, some of which also trigger actions on the SONET link. Table 3-4 describes these events and their associated actions. Syslog messages are output for these events.

Table 3-4: SONET Events

Event	Description
Loss of Signal (LOS)	Loss of Signal is detected by the Section Terminating Equipment (STE) when an all-zeroes pattern on the incoming SONET signal lasts 100 microseconds or longer. This condition can be caused by loss of light. SONET Action: Send RDI-L upon LOS detection.
Loss of Frame (LOF)	Loss of Frame is detected by the STE when a Severely Errored Framing (SEF) defect on the incoming signal persists for 3 milliseconds. Related SONET Overhead: A1, A2 (framing pattern). SONET Action: Send RDI-L upon LOF detection.
Loss of Pointer (LOP)	The Path Loss Of Pointer event is detected as a result of excess New Data Flags (NDFs) or invalid pointers in the H1/H2 fields of the received signal. Related SONET Overhead: H1,H2 contain NDF and pointer. SONET Action: Send RDI-P upon LOP detection.
Alarm Indication Signal—Line (AIS-L)	The Line Alarm Indication Signal is sent by the upstream STE to inform the LTE that a LOS or LOF defect has been detected. Extreme's SONET module never sends AIS-L. AIS-L was formerly known as Line Far End Receive Failure (FERF). Related SONET Overhead: K2 carries AIS-L. SONET Action: Send RDI-L upon reception of AIS-L.

Table 3-4: SONET Events (continued)

Event	Description
Alarm Indication Signal—Path (AIS-P)	The Path Alarm Indication Signal is sent by the upstream LTE to inform the PTE that a LOS, LOF, AIS-L, or LOP defect has been detected. Extreme's SONET module never sends AIS-P. AIS-P was formerly known as Path Far End Receive Failure (FERF).
	Related SONET Overhead: H1,H2,H3 = 0 when indicating AIS-P.
	SONET Action: Send RDI-P upon receiving AIS-P.
Remote Defect Indicator—Line (RDI-L)	The Line Remote Defect Indication is sent by the downstream LTE when a LOS, LOF, or AIS-L defect is detected.
	Related SONET Overhead: K2 carries RDI-L.
Remote Defect Indicator—Path (RDI-P)	The Path Remote Defect Indication is sent by the downstream PTE when a LOP or AIS-P defect is detected.
	Related SONET Overhead: G1 carries RDI-P.
Remote Error Indicator—Line (REI-L)	The Line Remote Error Indicator conveys a count of detected B2 parity errors from the peer LTE.
	Related SONET Overhead: M1 carries REI-L.
Remote Error Indicator—Path (REI-P)	The Path Remote Error Indicator conveys a count of detected B3 parity errors from the peer PTE.
	Related SONET Overhead: G1 carries REI-P.
Path Payload Label Mismatch (PLM-P)	The Path Payload Label Mismatch event occurs when the received payload type does not match the expected payload. This event is commonly caused by a Signal Label or scrambling mode mismatch configuration error.
	Related SONET Overhead: C2 carries the Signal Label.
Signal Failure Bit Error Rate (SF BER)	The Signal Failure BER event occurs when the B2 bit error rate exceeds the configured SF threshold. This event is used for APS switching.
	Related SONET Overhead: B2 carries line parity.
	SONET Action: Send RDI-L upon detecting SF BER event.
Signal Degrade Bit Error Rate (SD BER)	The Signal Degrade BER event occurs when the B2 bit error rate exceeds the configured SD threshold. This event is used for APS switching.
	Related SONET Overhead: B2 carries line parity.

Table 3-4: SONET Events (continued)

Event	Description
Automatic Protection Switching (APS)	An APS event occurs when the value of K1 or K2 changes. This event is an input to the APS state machine, which is responsible for handling the event and outputting the appropriate syslog message. The LOS, LOF, AIS-L, SF BER, and SD BER events are also input to the APS state machine. Related SONET Overhead: K1,K2

Configuring and Monitoring PPP Functions

In addition to the ExtremeWare commands for configuring slot and port behavior that are described in the *ExtremeWare Software User Guide*, this section describes the commands you use to configure PPP attributes for PoS module ports.

This section provides information on the following topics:

- PPP Background Information on page 3-22
- Commands for Configuring and Monitoring PPP Functions on page 3-26
- Configuring the PoS Checksum on page 3-27
- Configuring PoS Scrambling on page 3-27
- Configuring Link Maintenance on page 3-28
- Configuring PPP Link Quality Monitoring on page 3-29
- Configuring PPP Authentication on page 3-30
- Configuring the Name and Password for the Port on page 3-30
- Creating an Authentication Database Entry on page 3-31
- Configuring the Network Control Protocol on page 3-33
- Configuring the MPLS Control Protocol on page 3-34
- Configuring the Delayed-Down-Time Interval on page 3-35
- Displaying PPP Information on page 3-36
- Resetting PPP Configuration Parameter Values on page 3-37

Table 3-5 on page 3-26 describes the ExtremeWare commands you use to configure and monitor PPP functions.

PPP Background Information

The Point-to-Point Protocol (PPP) encompasses a suite of protocols designed to provide standard methods for transporting datagrams over point-to-point links. The use of PPP over SONET links is commonly referred to as Packet over SONET, or PoS. The Extreme Networks implementation of PPP for the PoS module provides support for the following protocols in the PPP suite:

- Link Control Protocol (LCP)
- Link Quality Report (LQR) Protocol

- Challenge Handshake Authentication Protocol (CHAP)
- Password Authentication Protocol (PAP)
- IP Control Protocol (IPCP)
- Bridging Control Protocol (BCP)
- MultiProtocol Label Switching Control Protocol (MPLSCP)
- Extreme Discovery Protocol Control Protocol (EDPCP)

Link Control Protocol. The Link Control Protocol (LCP) establishes a logical connection with the peer LCP entity through an exchange of configuration packets. Data traffic cannot flow over the SONET link until LCP has successfully established this connection. LCP is also responsible for negotiating options that are independent of particular network layer protocols, such as the Quality Report, Authentication Protocol, and Maximum Receive Unit options.

Quality Protocol Configuration Option. The LCP Quality Protocol configuration option can be used to specify the use of the Link Quality Report (LQR) Protocol to monitor the quality of the SONET link. If the LQR Protocol detects that the quality of the link is less than a configured threshold, all network layer protocols running over the link are brought down. This process of determining data loss and link viability is referred to as Link Quality Monitoring (LQM).

Link Maintenance Configuration Option. In addition to the LQR option, the Extreme Networks implementation of PPP also provides a Link Maintenance configuration option. When link maintenance is enabled on a port and that port is not receiving data packets, the link maintenance facility periodically transmits LCP echo-request packets. If an echo-reply is not received within a configured interval, LCP brings the link down.

Authentication Protocols. The Extreme Networks implementation of PPP uses the Challenge Handshake Authentication Protocol (CHAP) and the Password Authentication Protocol (PAP) to authenticate peer network elements. PAP is a simple protocol based on a clear-text user name and password pair, while CHAP is a stronger authentication protocol that uses the Message Digest, Version 5 (MD5) one-way hash algorithm. In the use of either protocol, if authentication fails, the connection with the peer is terminated.

IP Control Protocol. IPCP is a member of a family of Network Control Protocols (NCPs) defined for use with PPP. IPCP establishes and configures a connection to transport IP datagrams efficiently across a PPP link between two routers. When IPCP is

enabled on a PoS port, all data forwarded over the SONET link must be routed by the BlackDiamond 6800 series switch, as illustrated in Figure 3-6.

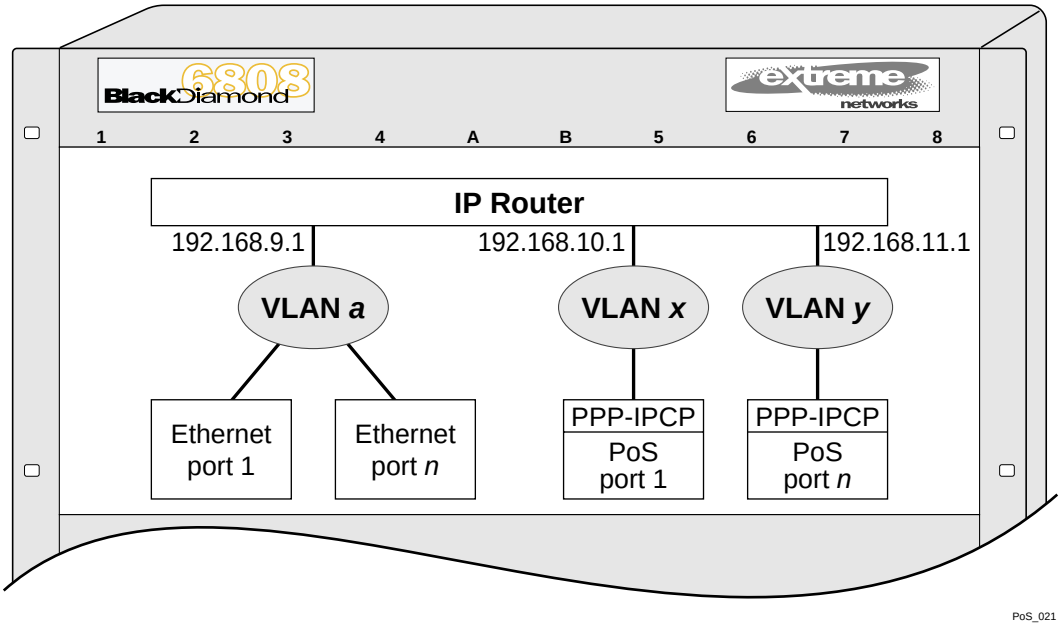


Figure 3-6: View of logical connectivity to PoS ports with IPCP enabled

Generally, when IPCP is enabled on a port, the port must be a member of one and only one VLAN. Furthermore, no other ports may be members of this VLAN, and IP routing is the only protocol supported on the VLAN. The one exception to this rule occurs when APS is enabled. A single VLAN may contain two IPCP-enabled ports if they are members of the same APS group.

Bridging Control Protocol. BCP establishes and configures a connection for transporting Ethernet MAC frames across a PPP link. The BCP link must be established successfully before data traffic can flow over the link. Because BCP carries Ethernet MAC frames, any protocol can be transported across a BCP connection. In a simplified sense, BCP allows the PoS link to appear as an Ethernet LAN segment to the rest of the switch, so BCP makes it possible for LAN services to be extended transparently across SONET wide-area networks. Therefore, the port can be a member of multiple VLANs, and frames can be either bridged or routed onto the link, as illustrated in Figure 3-7.

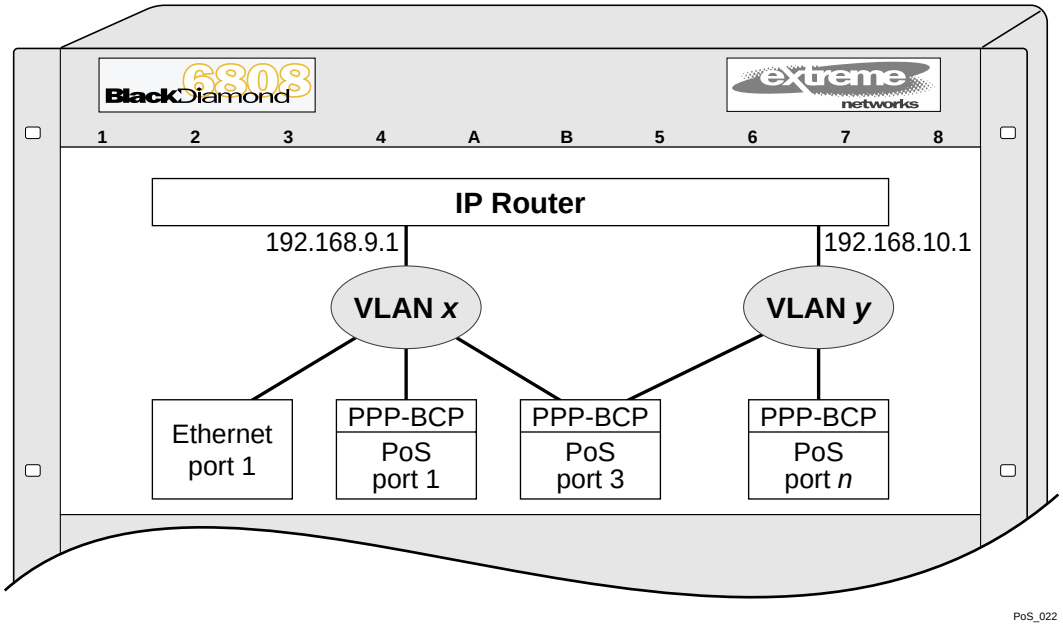


Figure 3-7: View of logical connectivity to PoS ports with BCP enabled

As Figure 3-7 shows, PoS ports 1 and 3 are bridged together along with Ethernet port 1 to form VLAN *x*, PoS port 3 belongs to both VLAN *x* and VLAN *y*, and routed connectivity exists between VLAN *x* and VLAN *y*.

BCP is defined in RFC 2878, which was recently approved by the IETF as an update to RFC 1638. Two features of the updated version are: support for IEEE 802.1Q VLANs, and inline management. The VLAN support enables a BCP entity to advertise its ability to accept frames containing a VLAN tag. Inline management refers to the capability of transporting the Spanning Tree Protocol and other bridge management protocols inline using the Bridged Data PPP Protocol ID (previously, RFC 1638 specified that Spanning Tree Protocol messages be transported using a unique PPP Protocol ID). Extreme's implementation supports these features as specified in the new RFC.

MultiProtocol Label Switching Control Protocol. MPLSCP establishes and configures a connection for transporting MPLS labeled frames across a PPP link. The MPLSCP connection must be established successfully before data traffic can flow over the link. Only unicast MPLS labeled packets are supported. Multicast MPLS labeled packets are discarded by the PoS port.

MPLSCP is not explicitly configured on a PoS port. Rather, MPLSCP is automatically enabled on a PoS port when the port is configured for IPCP, and MPLS is enabled on the VLAN that the PoS port is a member of. When MPLSCP is enabled on a PoS port, the port will transport IP and MPLS labeled packets, and the port must be a member of one and only one VLAN. Furthermore, no other ports may be members of this VLAN, and IP routing is the only protocol supported on the VLAN. The one exception to this rule occurs when APS is enabled. A single VLAN may contain two IPCP-enabled ports if they are members of the same APS group.

Extreme Discovery Protocol Control Protocol. EDPCP supports the exchange of EDP control packets across PoS links. EDP is used to gather information about neighboring Extreme switches, and to exchange topology information. EDPCP uses PPP protocol ID 0x820D; EDP packets use PPP protocol ID 0x020D. These PPP protocol IDs were assigned by the Internet Assigned Numbers Authority (IANA). When the PPP peer is from a vendor other than Extreme, EDPCP is disabled on the link.

Commands for Configuring and Monitoring PPP Functions

Table 3-5 describes the ExtremeWare commands you use to configure and monitor PPP functions. Each command is described in detail in the sections that follow.

Table 3-5: PPP Commands

Command	Description
config ppp [bcp [on | off] | ipcp [on {peer-ipaddress <ipaddress>} | off]] ports <portlist>	Configures the Network Control Protocol that will run on the specified PPP ports.
config ppp authentication [off | chap | pap | chap-pap] ports <portlist>	Configures authentication on the specified PPP ports.
config ppp delayed-down-time <seconds> ports <portlist>	Configures the delayed-down-time interval used by PPP for the specified ports.
config ppp echo [<seconds> <consecutive_misses> | off] ports <portlist>	Configures the link maintenance protocol on the specified ports.
config ppp pos checksum [32 | 16] ports <portlist>	Configures the size of the HDLC Frame Check Sequence (FCS) to be used on the specified SONET ports.
config ppp pos scrambling [on | off] ports <portlist>	Specifies whether the payload data should be scrambled on the specified SONET ports.
config ppp quality [off | <required_percent> {<seconds>}] ports <portlist>	Configures the Link Quality Monitoring (LQM) protocol on the specified ports.

Table 3-5: PPP Commands (continued)

Command	Description
config ppp user <name> {encrypted} {<password>} ports <portlist>	Configures the user name and password that the specified PPP ports use in the event the PPP peer requests authentication.
show ppp {<portlist>} {detail}	Displays status information for PPP ports.
unconfig ppp ports <portlist>	Resets the PPP configuration parameters for the specified ports to their default values.

The following command is an enhanced application of the existing ExtremeWare `create account` command. The `pppuser` keyword is used to specify the name of a local database entry that is used to authenticate PPP peers.

```
create account pppuser <name> {encrypted} {<password>}
```

The PPP use of this command is described in "Creating an Authentication Database Entry" on page 3-31.

Configuring the PoS Checksum

To configure the size of the HDLC Frame Check Sequence (FCS) to be used on the specified SONET port, use the following command:

```
config ppp pos checksum [32 | 16] ports <portlist>
```

Choose either the 32-bit FCS or the 16-bit FCS. A 32-bit FCS is the default. RFC 2615 recommends the use of the 32-bit FCS.

For OC-3 applications, RFC 2615 allows the use of a 16-bit FCS, but recommends using a 32-bit FCS. You should limit your use of the 16-bit FCS to supporting interoperability with equipment that does not support the 32-bit FCS.

The following command example sets the FCS to 16 for port 1 of the PoS module installed in slot 8 of the BlackDiamond switch.

```
config ppp pos checksum 16 ports 8:1
```

Configuring PoS Scrambling

To enable or disable payload data scrambling on the specified port, use the following command:

```
config ppp pos scrambling [on | off] ports <portlist>
```

Choose either `on` or `off`. Scrambling is enabled by default.

RFC 2615 recommends that the SONET payload be scrambled. The option of disabling scrambling is provided for backward compatibility with an earlier PoS standard. Scrambling was introduced in RFC 2615 to alleviate potential security problems where malicious users might intentionally generate packets with bit patterns that create SONET synchronization problems.

The following command example turns off the scrambling function for port 1 of the PoS module installed in slot 8 of the BlackDiamond switch.

```
config ppp pos scrambling off ports 8:1
```

Configuring Link Maintenance

The Extreme Networks implementation of PPP provides a link maintenance configuration option. When link maintenance is enabled on a port and that port is not receiving data packets, the link maintenance facility periodically transmits Link Control protocol (LCP) echo-request packets. If an echo-reply is not received within a configured interval, LCP brings the link down.

To enable the link maintenance protocol on a specified PPP port, use the following command:

```
config ppp echo [<seconds> <consecutive_misses> | off] ports <portlist>
```

The `seconds` parameter is an integer in the range from 1 to 300 that specifies the period between transmissions of echo-request packets.

The `consecutive_misses` parameter is an integer in the range from 1 to 100 that determines how long PPP waits for a reply. If an echo-reply is not received within an interval of duration (*consecutive_misses* * *seconds*) seconds, the link is brought down.

When APS is enabled on a SONET port, link maintenance should also be enabled on that port.

The link maintenance protocol is off by default. If you enable link maintenance, the recommended `seconds` value is 3, and the recommended `consecutive_misses` value is 10.

The following example enables link maintenance on port 1 of a PoS module in slot 8 and sets `seconds` to 3 and `consecutive misses` to 10.

```
config ppp echo 3 10 ports 8:1
```

Configuring PPP Link Quality Monitoring

The Link Control Protocol (LCP) establishes a logical connection with the peer LCP entity through an exchange of configuration packets. Data traffic cannot flow over the SONET link until LCP has successfully established this connection. LCP also allows the negotiation of a quality monitoring protocol to monitor the viability of the PPP link on a continuous basis. This process of determining data loss and link viability is referred to as Link Quality Monitoring (LQM).

The LQM protocol uses the Link Quality Report (LQR) packet as a mechanism in the test of the PPP link. The LQM protocol periodically transmits LQR packets containing counts of packets and octets that have been transmitted and successfully received. This information enables the LQM protocol to determine the percentage of data that is being dropped due to poor link quality. If the drop percentage is greater than a configured threshold, all network-layer protocols are brought down. Bringing a poor-quality link down may be desirable when an alternate network path exists, or when billing is based on the amount of data transmitted. By default, LQM is off.

To enable the LQM protocol on a specified PPP port, use the following command:

```
config ppp quality [off | <required_percent> {<seconds>}] ports <portlist>
```

The `required_percent` parameter is an integer in the range from 1 to 99 that is used to determine the drop percentage threshold, where:

drop percentage threshold = (100–<required_percent>).

The optional `seconds` parameter is an integer in the range from 1 to 300. This parameter value determines how often quality reports should be received from the peer LQR entity. If you do not specify a value for the `seconds` parameter, the command uses the default value of 30 seconds.

It can take up to seven reporting intervals for LCP to bring a link down. If the link quality improves subsequent to being brought down, LCP automatically brings the link back up. This type of service restoration takes a minimum of seven reporting intervals.

The following example enables the LQM protocol on port 1 of a PoS module in slot 3 and sets `required_percent` to 95. Because no value is specified for the optional `seconds` parameter, the command uses the default of 30 seconds.

```
config ppp quality 95 ports 3:1
```

Configuring PPP Authentication

The Extreme Networks implementation of PPP uses the Challenge Handshake Authentication Protocol (CHAP) and the Password Authentication Protocol (PAP) to authenticate peer network elements. PAP is a simple protocol based on a clear-text user name and password pair, while CHAP is a stronger authentication protocol that uses the Message Digest, Version 5 (MD5) one-way hash algorithm. In the use of either protocol, if authentication fails, the connection with the peer is terminated.

To configure authentication on a specified PPP port, use the following command:

```
config ppp authentication [off | chap | pap | chap-pap] ports <portlist>
```

The default is authentication `off`, meaning the peer is not authenticated.

When you configure authentication using the `chap` keyword, the peer is authenticated using CHAP.

When you configure authentication using the `pap` keyword, the peer is authenticated using PAP.

When you configure authentication using the `chap-pap` keyword, a request is made to authenticate the peer using CHAP, but PAP may be used if the peer does not support CHAP.

The following command example turns on CHAP authentication for port 1 of the PoS module installed in slot 8 of the BlackDiamond switch.

```
config ppp authentication chap ports 8:1
```

Configuring the Name and Password for the Port

In the event a PPP peer requests authentication, the Extreme Networks implementation of PPP responds to the peer's CHAP or PAP authentication requests regardless of whether the port is configured to authenticate the peer.

To configure the name and password for a specified PPP port, use the following command:

```
config ppp user <name> {encrypted} {<password>} ports <portlist>
```

The `name` and `password` parameters can contain a maximum of 32 alphanumeric characters each. As an option, you can use double quotation characters as delimiters to enclose the `name` and `password` parameters.

If you do not specify a `password` parameter in this command, the command prompts you to enter the new password two times: the first time to set the new password; the second time to confirm the password.

The factory default value for both the `name` and `password` parameters is the word *extreme.*

You should not attempt to use the `encrypted` *keyword. It is used by the switch when generating an ASCII configuration.*

The following command example sets the name to “titus” and sets the password to “1Afortune” for port 1 of the PoS module installed in slot 8 of the BlackDiamond switch.

```
config ppp user "titus" "1Afortune" ports 8:1
```

Creating an Authentication Database Entry

Responses to authentication requests include a username. When the requesting entity receives a response, it searches its local database for an entry with the specified username. When an entry is located, the associated password is used to validate the authentication response.

To create a local database entry that can be used to authenticate a PPP peer, use the following command:

```
create account pppuser <name> {encrypted} {<password>}
```

The `name` and `password` parameters are both character strings of up to 32 alphanumeric characters. Both strings must start with an alphabetic character, but can be any combination of alphanumerical characters thereafter. As an option, you can use double quotation characters as delimiters to enclose the `name` and `password` parameters.

If you do not specify a `password` string in this command, the command prompts you to enter the password two times: the first time to set the string; the second time to confirm it.

You should not attempt to use the `encrypted` *keyword. It is used by the switch when generating an ASCII configuration.*

The following command example sets the authentication database name to “stretch” and sets the password to “baserunner” for port 1 of the PoS module installed in slot 8 of the BlackDiamond switch.

```
create account pppuser "stretch" "baserunner" ports 8:1
```

Configuring the Network Control Protocol

The Network Control Protocol is configured on a per-port basis, meaning that different ports on the same module can be running either the Bridging Control Protocol (BCP) or the IP Control Protocol (IPCP)—both protocols cannot be configured at the same time on any port.

Generally, when IPCP is configured on a port, that port must be a member of a single VLAN. Further, no other ports on this switch can be members of this VLAN, and IP routing is the only protocol supported on this VLAN. The one exception to this rule is when Automatic Protection Switching (APS) is enabled. In which case, a single VLAN may contain two ports configured for IPCP if they are both members of the same APS group.

For more information about setting up VLANs, see the ExtremeWare Software User Guide*.*

BCP establishes and configures a connection for transporting Ethernet MAC frames across a PPP link. Because BCP carries Ethernet MAC frames, any protocol can be transported across a BCP connection. In a simplified sense, BCP allows the PoS link to appear as an Ethernet LAN segment to the rest of the switch, so BCP makes it possible for LAN services to be extended transparently across SONET wide-area networks. Therefore, the port can be a member of multiple VLANs, and frames can be either bridged or routed onto the link.

Generally, most of the switch capabilities provided for Ethernet ports are also available for PoS ports configured for BCP. One exception is that there are restrictions on which OC-3 PoS module ports can be bridged together (be configured as members of the same VLAN). Ports 1 and 2 on the same OC-3 PoS module cannot be bridged together, and ports 3 and 4 on the same OC-3 PoS module cannot be bridged together—unless they are members of the same APS group. There are no such restrictions on OC-12 PoS module ports.

To configure the Network Control Protocol for a specified PPP port, use the following command:

```
config ppp [bcp [on | off] | ipcp [on {peer-ipaddress <ipaddress>} | off]]
   ports <portlist>
```

By default, BCP is enabled on all PoS ports. BCP cannot be configured on a port unless IPCP is off; IPCP cannot be configured on a port unless BCP is off.

When used with IPCP, the optional `peer-ipaddress` keyword and parameter value provides a way to configure the IP address of the peer router. This capability is useful with peer routers that do not advertise their IP address through the IPCP IP-Address configuration option. If the peer router does advertise an IP address through IPCP, the configured value for `peer-ipaddress` is ignored.

The following command example turns IPCP off and BCP on for port 1 of the PoS module installed in slot 8 of the BlackDiamond switch.

```
config ppp ipcp off port 8:1
config ppp bcp on port 8:1
```

Configuring the MPLS Control Protocol

MPLSCP establishes and configures a connection for transporting MPLS labeled frames across a PPP link. The MPLSCP connection must be established successfully before MPLS labeled data traffic can flow over the link. Only unicast MPLS labeled packets are supported. Multicast MPLS labeled packets are discarded by the PoS port.

MPLSCP is not explicitly configured on a PoS port. However, MPLSCP is automatically enabled on a PoS port when the port is configured for IPCP and MPLS is enabled on the VLAN that the PoS port is a member of. When MPLSCP is enabled on a PoS port, the port will transport IP and MPLS labeled packets, and the port must be a member of one and only one VLAN. Furthermore, no other ports may be members of this VLAN, and IP routing is the only protocol supported on the VLAN. The one exception to this rule occurs when APS is enabled. A single VLAN may contain two IPCP-enabled ports if they are members of the same APS group.

You must have a PoS module and an MPLS module installed in your BlackDiamond switch to use MPLS on a PoS port.

To configure MPLSCP on a PoS port, complete the following steps:

1. Create a VLAN for the PoS port using the `create vlan <name>` command.
2. Add the PoS port to the VLAN using the `config vlan <name> add ports <port>` command.
3. Define an IP router port on the VLAN by assigning an IP address to the VLAN using the `config vlan <name> ipaddress <ipaddress> {<mask>}` command.
4. Disable BCP on the PoS port using the `config ppp bcp off ports <portlist>` command and enable IPCP on the PoS port using the `config ppp ipcp on ports <portlist>` command.

5 Configure MPLS on the VLAN using the `config mpls add vlan [<name> | all]` command.

The following command example creates a VLAN named *vlan1* and configures MPLSCP on PoS port 8:1 on VLAN *vlan1*:

```
create vlan vlan1
config vlan vlan1 add ports 8:1
config vlan vlan1 ipaddress 192.168.100.1
config ppp bcp off ports 8:1
config ppp ipcp on ports 8:1
config mpls add vlan vlan1
```

For more information about MPLS and configuring MPLS, see the *MPLS Installation and User Guide*.

Configuring the Delayed-Down-Time Interval

The delayed-down-time interval is the amount of time that PPP waits before declaring a port down after a physical link failure has been detected. A non-zero value is useful when recovery from the link failure is fast, for example, when APS is enabled on a SONET port. In this case, APS may recover from the link failure before PPP responds, thereby minimizing network down time. Generally, you should set a non-zero value for the delayed-down-time interval any time APS is configured at either end of the link.

To configure the delayed-down-time interval for a specified PPP port, use the following command:

```
config ppp delayed-down-time <seconds> ports <portlist>
```

The value of the `seconds` parameter is an integer number in the range from 0 to 20 seconds. The default is 1 second.

A delayed-down-time interval of one second is usually sufficient to accommodate APS line switches.

The following command example sets the delayed-down-time interval to 2 seconds for port 1 of the PoS module installed in slot 8 of the BlackDiamond switch.

```
config ppp delayed-down-time 2 ports 8:1
```

Displaying PPP Information

To display status information for PPP ports, use the following command:

```
show ppp {<portlist>} {detail}
```

If you enter the `show ppp` command without an argument or keyword, the command displays status information for all PPP ports. Use the optional `portlist` parameter to display status information for one or more specific ports.

By default, the command displays a summary of status information for the specified PPP port. Use the `detail` keyword to display detailed status information.

The summary display includes the following status information for each PPP port:

- Values of all PPP configuration parameters
- Physical link status

The detailed display includes the information reported in the summary display, and adds the following status and management counters:

- Detailed link status:
  - PPP link phase
  - LCP state
  - BCP or IPCP state
  - EDPCP state
  - Link packet and octet counters
- Detailed LCP status:
  - LCP options negotiated (local and remote)
  - LCP packet counters
  - Number of link-down events due to PPP maintenance
- Detailed authentication status:
  - Remote username (if applicable)
  - CHAP or PAP packet counters
- Detailed BCP or IPCP status:
  - Options negotiated (local and remote)
  - Packet counters

- Detailed LQM status:
  - — Statistics from the most recent Link Quality Report (LQR)
  - — Time since the most recent LQR
  - — LQR packet counters
  - — Number of link-down events due to LQM

Resetting PPP Configuration Parameter Values

To reset the PPP configuration parameters for the specified port to their default values, use the following command:

```
unconfig ppp ports <portlist>
```

Configuring VLAN-Related Attributes

The ExtremeWare software and the Extreme Networks switch architecture provide a range of Virtual Local Area Network (VLAN) features, which are described in detail in the *ExtremeWare Software User Guide*. This section describes how these features are supported on the PoS module.

This section assumes some familiarity with the Extreme Networks implementation of VLAN features as described in the ExtremeWare Software User Guide*. For more information about VLAN-related features supported by ExtremeWare, see the* ExtremeWare Software User Guide*.*

Summary of VLAN-Related Commands

Table 3-6 lists the ExtremeWare VLAN-related commands that support the PoS module. Each command is described in detail in the sections that follow.

Table 3-6: VLAN-related Commands

Command	Description
config dot1q tagmapping <input_vlanid/output_vlanid> ports <portlist> {egress {priority <priority>} | ingress {priority <priority>}}	Configures the VLAN tag mapping tables for a PoS port.
config dot1q tagnesting {<vlanid> | <vlanid_range>} [off | pop | push <new_vlanid> {priority <priority>}] ports <portlist> {egress | ingress}	Configures the VLAN tag nesting attributes for a PoS port.

PoS module ports do not support protocol-based VLANs or MAC address VLANs. Thus, there are restrictions on the use of the following commands:

- `config vlan <name> [add | delete] ports <portlist> {tagged | untagged} {nobroadcast}`
- `config vlan <name> protocol [<protocol_name> | any]`
- `enable mac-vlan mac-group [any | group_number] ports <portlist>`

The restrictions are as follows:

- A PoS port cannot be added to a VLAN if the VLAN is a protocol-based VLAN.
- A VLAN cannot be configured to be a protocol-based VLAN if the VLAN contains a PoS port.
- A MAC address VLAN cannot be enabled on a PoS port.

The `config vlan <name> protocol any` command is supported, because it can be used to configure the default VLAN for PoS ports.

In the `config vlan <name> [add | delete] ports <portlist> {tagged | untagged} {nobroadcast}` command, PoS ports support the optional `tagged` and `untagged` keywords when BCP is enabled, and ignore them when IPCP is enabled.

IPCP and BCP are mutually exclusive configuration options for a given PoS port: they cannot both be enabled simultaneously on the same PoS port. Generally, when IPCP is enabled on a port, the port must be a member of one and only one VLAN. Furthermore, no other ports may be members of this VLAN, and IP routing is the only protocol supported on the VLAN. The one exception to this rule occurs when APS is enabled. A single VLAN may contain two IPCP-enabled ports if they are members of the same APS group.

Configuring Tagged VLAN 802.1p and 802.1Q Functions

The dot1q tag mapping and tag nesting commands are supported only by PoS ports and apply only when BCP is enabled on the PoS port.

The following ExtremeWare commands are supported for the PoS module:

- `config dot1q ethertype <ethertype>`
- `config dot1p type dot1p_priority <priority> qosprofile <qosprofile>`

If a PoS port receives a frame with a priority value "n" that is not mapped to a profile in the range from qp1 through qp8, the frame is assigned to QoS profile qp_{n+1}.

The following commands provide PoS module support for managing 802.1Q tags:

- `config dot1q tagmapping`
- `config dot1q tagnesting`

Configuring VLAN Tag Mapping Tables

The `config dot1q tagmapping` command provides support for VLAN ID (VID) mapping tables. Each PoS port supports two VID tables: one table is used in the ingress direction; the other is used in the egress direction. These tables make it possible to map an input VID to an output VID, which can be useful in reconciling policy differences at the boundary between the customer and the service provider. The tables also allow the option of preserving the 802.1p priority or overwriting the priority with a configured value.

To configure the VLAN tag mapping tables for a PoS port, use the following command:

```
config dot1q tagmapping <input_vlanid/output_vlanid> ports <portlist>
   {egress {priority <priority>} | ingress {priority <priority>}}
```

The `input_vlanid` and `output_vlanid` parameters are both integers in the range from 1 to 4095 and must be separated by a slash character.

The `priority` parameter is an integer in the range from 0 to 7.

Use the `egress` keyword to apply the mapping of the input VLAN ID to the output VLAN ID to frames received from the switch backplane prior to transmitting them onto the PPP link. Use the `ingress` keyword to apply the mapping to input frames received from the PPP link. The mappings are applied after they are classified to a QoS profile. Frames containing the VLAN ID specified in `input_vlanid` are changed so that the VLAN ID is set to the value specified in `output_vlanid` before the frame is forwarded.

If you omit both the `egress` and the `ingress` keywords, the command automatically applies the specified mapping to the egress direction, and also applies a symmetrical mapping (with the `input_vlanid` and `output_vlanid` values reversed) to the ingress direction.

These tables also give you the option of preserving the 802.1p priority or overwriting the priority with a user-configured value. Using the `priority` keyword in the command indicates that the 802.1p priority field is to be set to the value specified in `priority`. To preserve the 802.1p priority, do not enter the `priority` keyword and value when using this command.

The default behavior is that the tables are initialized such that VLAN IDs are not altered by the mapping operations, and frame priority is preserved. For example, an input VLAN ID of *n* is always mapped to an output VLAN ID of *n*, and the 802.1p priority field is not changed.

Configuring VLAN Tag Nesting Attributes

The `config dot1q tagnesting` command provides support for 802.1Q tags by allowing a tag *push* or *pop* attribute to be associated with a VLAN ID. The push attribute indicates that a new tag is to be added to the frame, while the pop attribute indicates that the top-level tag is to be removed from the frame. The command also gives you the option to preserve the 802.1p priority of the frame or set it to a configured value when a new tag is added (pushed) to the frame. VLAN ID (VID) mapping occurs before a new tag is pushed, and after a nested tag is popped.

To configure the VLAN tag nesting attributes for a PoS port, use the following command:

```
config dot1q tagnesting {<vlanid> | <vlanid_range>} [off | pop |
push <new_vlanid> {priority <priority>}] ports <portlist> {egress | ingress}
```

The `vlanid` parameter is an integer in the range from 1 to 4095. The `vlanid_range` parameter is specified in the form `start_vlanid-end_vlanid`, where the start and end values are both integers in the range from 1 to 4095 and must be separated by a hyphen.

The `push` keyword indicates that a new tag is to be added to frames containing the VID specified in `vlanid` or to one of the VIDs in the range specified in `vlanid_range`. The new tag added to frames contains the value specified in `new_vlanid`.

The `pop` keyword indicates that the top-level tag is to be removed from frames when that tag contains either the VID specified in `vlanid` or any one of the VIDs in the range specified in `vlanid_range`.

If you do not specify a VID or a range of VIDs, the command settings are applied to all VIDs.

Tag operations can be performed in either the egress direction (to the SONET link) or the ingress direction (from the SONET link). If you do not specify a direction, the default behavior is that tag operations are performed in the egress direction. If you do not use either the `egress` or `ingress` keyword and tag pushing is configured, a corresponding tag pop operation is automatically configured for the ingress direction. If you do not use either the egress or ingress keyword and tag nesting is disabled using the `off` keyword, tag nesting is disabled in both directions.

The optional `priority` keyword provides a way to overwrite the 802.1p priority with a user-configured value when a new tag is pushed. Using the `priority` keyword in the command indicates that the 802.1p priority field is to be set to the value specified in

priority, which is an integer in the range from 0 to 7. To preserve the 802.1p priority, do not enter the priority keyword and value when using this command.

Default behavior is that tag nesting is disabled (off) for all VLAN IDs.

Tag push operations apply to egress frames only when the port is configured to transmit tagged frames for the associated VLAN. Tag nesting operations apply only to ingress frames that contain a VLAN tag. Tag nesting operations are applied after classification to a QoS profile.

The default PPP MRU is sufficient for a single level of tag nesting (where the frame contains two VLAN tags) between two Extreme Networks switches. If higher levels of VLAN tag nesting are needed, jumbo frame support must be enabled.

The DiffServ and RED functions are not performed by PoS ports when frames contain nested tags (more than one tag).

Generic VLAN Registration Protocol Functions

The Generic VLAN Registration Protocol (GVRP) is not supported on PoS module ports, so the following command will not work if you specify a PoS port:

```
config gvrp {listen | send | both | none] ports <portlist>
```

Configuring Forwarding Database Attributes

PoS ports support all of the existing ExtremeWare forwarding database (FDB) commands. For more information on these commands, see the *ExtremeWare Software User Guide*.

Configuring Spanning Tree Attributes

PoS ports support all of the existing ExtremeWare Spanning Tree commands.

Configuring QoS Functions

The ExtremeWare software and the Extreme Networks switch architecture provide a number of Quality of Service (QoS) functions, which are described in detail in the *ExtremeWare Software User Guide*. This section describes how these QoS functions, such as Differentiated Services (DiffServ) and Random Early Detection (RED) are supported on the PoS module.

This section assumes some familiarity with the Extreme Networks implementation of QoS and DiffServ features as described in the ExtremeWare Software User Guide*. For more information about QoS and DiffServ features supported by ExtremeWare, see the* ExtremeWare Software User Guide*.*

This section contains information on the following topics:

- Summary of QoS-Related Commands on page 3-43
- Configuring a QoS Profile on page 3-44
- Classification and Replacement Policies on page 3-46
- Configuring DiffServ on page 3-47
- Enhanced RED Support on page 3-51

Summary of QoS-Related Commands

Table 3-7 contains an alphabetical list of the QoS-related commands that support the PoS module. Commands with keywords or parameters shown in italic typeface are existing ExtremeWare commands that have been enhanced to support the PoS module. Each command is described in detail in the sections that follow.

Table 3-7: QoS-Related Commands

Command	Description
config diffserv dscp-mapping <input_codepoint>/<output_codepoint> ports <portlist> {egress {no-congestion | congestion} | ingress}	Configures a mapping between an input DiffServ code point (DSCP) and an associated output DSCP for the specified PoS ports.
config diffserv examination code-point <code_point> qosprofile <qosprofile> ports <portlist> {*low-drop-probability* | *high-drop-probability*}	Configures the mapping between a DSCP and a specified QoS profile. Added keywords for low-drop-probability and high-drop-probability.

Table 3-7: QoS-Related Commands (continued)

Command	Description
config red [drop-probability | *low-drop-probability* | *high-drop-probability*] <percent> {*ports* <*portlist*>}	Configures the RED drop probability for a specified port. Added keywords for low-drop-probability and high-drop-probability; added optional keyword and argument to specify ports.
config red min-threshold <percent> ports <portlist>	Configures the minimum queue length threshold for RED operation on the specified PoS ports.
config qosprofile <qosprofile> {minbw <percent>} {maxbw <percent>} {priority <level>} {minbuf <percent>} {maxbuf <percent>} {<portlist>} {*egress* | *ingress*}	Configures a QoS profile. Added optional egress and ingress keywords.
disable red ports <portlist> {*queue* <*queue#*>}	Disables RED on the specified PoS ports. Added optional keyword and argument to specify the queue number.
enable red ports <portlist> {*queue* <*queue#*>}	Enables RED on the specified PoS ports. Added optional keyword and argument to specify the queue number.
show ports info detail	Displays detailed system-related information. Command output enhanced to display RED configuration information.
unconfig diffserv dscp-mapping ports <portlist>	Resets the DSCP mapping tables for the specified PoS ports to their default values.

Configuring a QoS Profile

The SONET modules support eight ingress queues and eight egress queues per port. The scheduling parameters (minimum bandwidth, maximum bandwidth and priority level) for these queues are controlled by QoS profiles qp1 through qp8, which are defined using the existing ExtremeWare `config qosprofile` command.

This command has been enhanced to allow you to configure more module-specific parameters on a port-by-port basis, including the ability to customize the QoS profile parameters for individual ingress or egress queues on a specific SONET port.

The syntax and description of the enhanced `config qosprofile` command are described below.

To configure the scheduling parameters for a specified QoS profile, use the following command:

```
config qosprofile <qosprofile> {minbw <percent>} {maxbw <percent>}
   {priority <level>} {minbuf <percent>} {maxbuf <percent>} {<portlist>}
   {egress | ingress}
```

The optional `egress` and `ingress` keywords apply only to PoS ports. As stated earlier, the PoS modules support eight egress queues and eight ingress queues per port, and the scheduling parameters for these queues are controlled by QoS profiles qp1-qp8, which means queue #0 is controlled by qp1, queue #1 is controlled by qp2, and so on.

The optional `portlist` parameter allows QoS profiles to be customized on a port-by-port basis for the PoS modules. The `egress` and `ingress` keywords allow you to fine-tune the customization (down to a particular egress or ingress queue on a given port). If you do not enter either the `egress` or `ingress` keyword in the command, the configured parameters apply to the egress queue associated with the specified QoS profile by default.

The `minbw` parameter specifies the minimum percentage of the bandwidth guaranteed to be available to the specified queue for transmissions from the QoS profile. The value is an integer in the range from 0 through 100. The default value is 0. The sum of the minimum bandwidth parameters across all eight QoS profiles cannot exceed 90%.

The `maxbw` parameter specifies the maximum percentage of the bandwidth that the specified queue can use for transmissions from the QoS profile. The value is an integer in the range from 1 through 100. The default value is 100.

The optional `priority` keyword and `level` parameter specify the service priority for the specified queue. The service priority determines which traffic is scheduled when bandwidth is still available after the minimum requirements of all profiles have been satisfied. Settings for `level` include: low, lowHi, normal, normalHi, medium, mediumHi, high, or highHi. The default setting is low.

The `minbuf` *and* `maxbuf` *keywords do not apply to PoS ports.*

Classification and Replacement Policies

This section deals primarily with classification operations performed by IPCP or BCP configured PoS ports.

Most of the existing ingress classification functions are supported for IPCP or BCP configured PoS ports. Functions such as access list and destination MAC address QoS policies are supported, as is the `enable diffserv replacement` command.

Egress frames are always assigned to a QoS profile based on their 802.1p priority. Thus, when a PoS port receives a frame from the switch fabric with a priority value *n*, that frame is assigned to egress QoS profile qp*n*+1.

The existing `enable diffserv examination ports` and `disable diffserv examination ports` commands are used on PoS ports to control whether the DiffServ code point (DSCP) is examined for ingress classification purposes.

When you enable the PPP Bridging Control Protocol (BCP) on a PoS port, non-IP frames that contain a VLAN tag are assigned to an ingress QoS profile based on their 802.1p priority value. You can configure this assignment using the `config dot1p type` command, which is used to specify the mappings between 802.1p priority values and QoS profiles. However, if a PoS port receives a frame with a priority value *n*, for which there is no mapping to one of the eight profiles (qp1-qp8), that frame is assigned to ingress QoS profile qp*n*+1.

If `diffserv examination` is not enabled, then the preceding 802.1p priority classification rules are applied to tagged IP frames as well.

In both cases, untagged frames are assigned to a single ingress QoS profile (provided that the port is an untagged member of a VLAN; if that is not the case, then untagged frames are discarded). This QoS profile defaults to qp1, but you can assign it to another profile using the `config ports <portlist> qosprofile <qosprofile>` command or the `config vlan <name> qosprofile <qosprofile>` command (where the port-based QoS configuration has higher precedence than VLAN-based QoS).

Additionally, if you enable the PPP IP Control Protocol (IPCP) on a PoS port and do not enable `diffserv examination` on the port, then all ingress frames (received from the SONET link) are assigned to a single ingress QoS profile. The profile defaults to qp1, but you can configure it to another profile using the `config ports <portlist> qosprofile <qosprofile>` command or the `config vlan <name> qosprofile <qosprofile>` command.

If you enable `diffserv examination` on a PoS port, then ingress IP frames are assigned to a QoS profile based on the DiffServ code point (regardless of whether you enabled either BCP or IPCP on the port). The existing `config diffserv examination code-point` command maps DiffServ code points to QoS profiles. This command has been enhanced for use with PoS ports. The syntax and description of the enhanced `config diffserv examination code-point` command are given below.

Also note that, in all cases, the 802.1p priority bits of ingress frames forwarded to the switch backplane are set based on the ingress QoS profile classification. More specifically, the 802.1p priority value is set to qp# – 1. For example, if the packet is classified to qp5, then the 802.1p priority value is set to 4.

When you enable MPLSCP on a PoS port, classification for MPLS labeled packets is done based only on the EXP bits in the label stack entry of the ingress frame. The EXP bits are used to map an ingress frame to an 802.1p priority and assigned to the corresponding ingress queue. Before the frame is forwarded to the switch backplane, the 802.1p bits in the frame are set based on the exp-to-dot1p mapping. You can use the `config mpls qos-mapping exp-to-dot1p` command to configure the EXP to 802.1p mapping. You can use the `config dot1p type dot1p_priority` command to configure the 802.1p to QoS mapping.

When you configure MPLSCP on a PoS port, other types of ingress commands such as `config diffserv examination code-point`, `config ports <portlist> qosprofile`, and `config vlan <name> qosprofile` are supported only for IPCP data frames and not MPLS labeled frames. Similarly, egress replacement commands such as `enable dot1p replacement` and `enable diffserv replacement` are supported only for IPCP data frame and not MPLS labeled frames.

Configuring DiffServ

All of the existing ExtremeWare DiffServ commands are supported by PoS ports with IP frames that are encapsulated in BCP or IPCP, not MPLSCP (including the enhancements to the `config diffserv examination code-point` command, described earlier in this chapter). PoS ports also support a DiffServ code point (DSCP) mapping function that you configure using the `config diffserv dscp-mapping` command, which is described below. The DSCP is a 6-bit value in the IP-TOS byte of the IP packet header. For more information on DSCPs, see “Configuring DiffServ” in the *ExtremeWare Software User Guide*.

DiffServ Classification

When a packet arrives at the switch on an ingress port, the switch examines the first six of eight TOS bits, called the *code point*. The switch can assign the QoS profile used to subsequently transmit the packet based on the code point. The QoS profile controls a hardware queue used when transmitting the packet out of the switch, and determines the forwarding characteristics of a particular code point. The examination of DiffServ information is disabled by default. To enable examination of DiffServ information, use the command:

```
enable diffserv examination ports [<portlist> | all]
```

Changing DiffServ Code Point Assignments in the QoS Profile

Because the code point uses six bits, it has 64 possible values ($2^6 = 64$). By default, the values are grouped and assigned to the default QoS profiles listed in Table 3-8.

Table 3-8: Default Code Point-to-QoS Profile Mapping

Code Point	QoS Profile
0-7	Qp1
8-15	Qp2
16-23	Qp3
24-31	Qp4
32-39	Qp5
40-47	Qp6
48-55	Qp7
56-63	Qp8

To configure the mapping between a DiffServ code point and a specified QoS profile, use the following command:

```
config diffserv examination code-point <code_point>
   qosprofile <qosprofile> ports <portlist>
   {low-drop-probability | high-drop-probability}
```

The mapping is applied in the ingress direction—for IP packets received from the SONET link.

The optional `low-drop-probability` and `high-drop-probability` keywords apply only to PoS ports. If you do not enter either of these keywords in the command, the command uses `low-drop-probability` as the default.

The `low-drop-probability` and `high-drop-probability` keywords are useful in conjunction with the Weighted RED (WRED) implementation provided by PoS ports. This implementation supports two different drop probabilities: one for DiffServ code points designated as having low drop-probability; another for DiffServ code points designated as having high drop-probability. These keywords give you complete flexibility in assigning DiffServ code points to these two drop-probability levels.

Configuring DiffServ Code Point Mapping Tables

You can use the `diffserv dscp-mapping` command to configure a mapped relationship between an input DSCP and an associated output DSCP. Each PoS port supports three DSCP mapping tables: one of the tables is used in the ingress direction; two are used for egress flows (onto the SONET link). The two egress tables are for the congested and noncongested states, as determined by the RED algorithm. If RED is not enabled on the PoS port, the egress congested-state mapping table is not used.

In the ingress direction, the input DSCP of a packet received from the SONET link is replaced by an output DSCP before the packet is forwarded. In the egress direction, the operation is similar, except that the DSCP mapping occurs before the packet is transmitted onto the SONET link.

One potential use of the DSCP mapping capability is to reconcile varying DiffServ policies at the boundary between autonomous systems, such as at the boundary between two ISPs. The availability of different tables for the congested and noncongested states is useful in marking operations that increase the probability of packets being dropped during times of congestion, as discussed in the DiffServ Assured Forwarding RFC (RFC 2597).

This command applies only to PoS ports with IP frames that are encapsulated in BCP or IPCP, not MLSCP. You should also be aware that DSCP mapping is performed even when the `diffserv examination` *function is disabled on the port.*

To configure the mapping between an input DSCP and an associated output DSCP, use the following command:

```
config diffserv dscp-mapping <input_codepoint>/<output_codepoint>
   ports <portlist> {egress {no-congestion | congestion} | ingress}
```

where:

`input_codepoint`	Specifies one of the 64 possible DiffServ code point values as the input code point.
`output_codepoint`	Specifies one of the 64 possible DiffServ code point values as the output code point.
`egress`	Applies the DSCP mapping to the egress direction.
`no-congestion`	Applies the DSCP mapping to the egress mapping table for the non-congested state.
`congestion`	Applies the DSCP mapping to the egress mapping table for the congested state.
`ingress`	Applies the DSCP mapping to the ingress direction.

If you omit the `no-congestion` and `congestion` keywords, the command applies the mapping to the tables for both states.

If you omit the `egress` and `ingress` keywords, the command applies the mapping to the egress direction, and automatically configures a symmetrical mapping (with the `input_codepoint` and `output_codepoint` values reversed) in the ingress direction.

By default, all the tables are initialized such that DSCPs are not altered by the mapping operations. For example, an input DSCP value of *n* is always mapped to an output DSCP value of *n*.

Resetting DiffServ Code Point Mapping Tables

To reset the DSCP mapping tables for a specified PoS port to their default values, use the following command:

```
unconfig diffserv dscp-mapping ports <portlist>
```

Replacing DiffServ Code Points

To replace DiffServ code points, you must use the following command to enable DiffServ replacement:

```
enable diffserv replacement ports [<portlist> | all]
```

You then change the 802.1p priority to DiffServ code point mapping to any code point value using the following command:

```
config diffserv replacement priority <vpri> code_point <code_point>
ports [<portlist> | all]
```

By doing so, the hardware queue used to transmit a packet determines the DiffServ value replaced in the IP packet.

To verify the DiffServ configuration, use the command:

```
show ports <portlist> info detail
```

Enhanced RED Support

Random Early Detection (RED) is a congestion avoidance mechanism. The basic idea behind RED is that most data transports detect packet loss and will, therefore, restrain transmission—if only temporarily—when they detect dropped packets. Consequently, if the switch needs to signal another device to slow transmission due to congestion, RED provides a way of intelligently dropping packets.

This section describes the changes and additions to ExtremeWare to support RED in conjunction with PoS modules that have IP frames encapsulated in BCP or IPCP, not MPLSCP. The Extreme implementation of RED combines the functions of the RED algorithm with IP precedence to provide support for preferential traffic handling for higher-priority packets. This implementation provides weighted RED (WRED) functionality through two packet-drop probabilities (described below), so that a device can selectively drop lower-priority traffic when an interface begins to show signs of congestion. This capability is combined with DiffServ attributes to allow you to tailor performance characteristics for different classes of service.

Configuring RED Drop Probability

To configure the RED drop probability for a specified PoS port, use the following command:

```
config red [drop-probability | low-drop-probability | high-drop-probability]
   <percent> {ports <portlist>}
```

The optional `low-drop-probability`, `high-drop-probability`, and `ports` keywords are supported only for SONET ports.

If you omit the `ports` keyword, the command applies the setting to all ports.

The drop probability is specified as a percentage, where the `percent` parameter is an integer in the range from 1 to 100.

Weighted RED (WRED) functionality is supported through two different drop probabilities: a low-drop-probability and a high-drop-probability. The DiffServ code points of IP packets indicate whether the packet should be dropped with low probability or high probability, and the appropriate percentage is then applied if WRED is active.

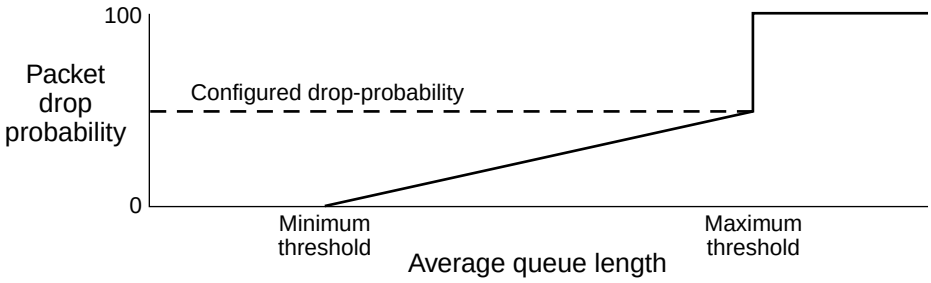
WRED is applied only to IP packets. The `config diffserv examination code-point` *command gives you complete flexibility in assigning DSCPs to the two different drop-probability levels. This configured mapping of DSCPs to drop-probability levels is used by WRED even if* `diffserv examination` *is disabled on the port.*

The `drop-probability` keyword indicates that the specified percentage should be used for both the low and high drop-probabilities. This effectively disables WRED and reverts to standard RED operation. For SONET ports, both the low and high drop-probabilities default to 10%.

The role of the configured drop probability in RED operation on SONET ports is illustrated in Figure 3-8A. RED is active when the average queue length is between the minimum and maximum thresholds. In this region, the probability that a given packet is dropped increases in a straight line up to the configured drop probability at the maximum threshold. All packets are dropped when the average queue length exceeds the maximum threshold.

The operation of WRED on SONET ports is depicted in Figure 3-8B. In this case, the drop probability depends not only on the average queue length, but also upon whether the DSCP indicates that the packet should be dropped with a low or high probability, which is to say, the DSCP of the packet controls which curve is used.

A. RED Operation on SONET Ports



B. WRED Operation on SONET Ports

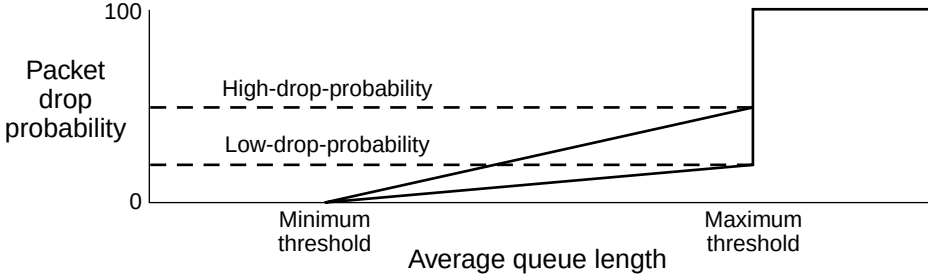


Figure 3-8: Comparisons of RED and WRED operation

Enabling and Disabling RED Ports

The existing ExtremeWare commands to enable and disable RED ports have been enhanced to provide RED configuration attributes for the PoS modules. Because the PoS modules support eight egress queues per port, the commands were enhanced to allow the user a way to enable RED selectively on an individual port and queue basis. By default, RED is disabled.

To enable RED on a specified PoS port, use the following command:

```
enable red ports <portlist> {queue <queue#>}
```

To disable RED on a specified PoS port, use the following command:

```
disable red ports <portlist> {queue <queue#>}
```

The optional `queue` keyword applies only to SONET ports. You can use this keyword to enable or disable the RED function on an individual queue basis.

The `queue#` parameter is an integer in the range from 0 to 7, and identifies one of the eight egress queues. If you omit the `queue` keyword, the command applies to all of the queues for the PoS port.

Configuring the RED Minimum Queue Length Threshold

The packet drop probability is based, in part, on the RED minimum queue length threshold. When the average queue length exceeds this threshold, the RED algorithm is activated and begins dropping packets. The packet drop rate increases in a linear fashion as the average queue length increases or until the average queue length hits the maximum threshold.

This command applies only to SONET ports.

To configure the minimum queue length threshold for RED operation on a specified PoS port, use the following command:

```
config red min-threshold <percent> ports <portlist>
```

The threshold value is specified as a percentage in the range from 1 to 100. For SONET ports, the minimum threshold is a percentage of 1000 packet buffers, and the maximum threshold is set to the value calculated by the formula:

*minimum ((3 * minimum threshold buffers), maximum available buffers)*

By default, the minimum threshold for SONET ports is 10%, or 100 buffers; thus, the default maximum threshold is 300 buffers.

You can use the `show ports info detail` command to display the settings of the minimum and maximum thresholds, displayed in terms of the number of buffers.

Use the `ports` keyword to configure the threshold parameter on specific SONET ports.

Support for Standard Per-Hop Behaviors

The per-hop behavior (PHB) describes the externally observable packet forwarding handling (or "behavior") to be applied by the receiving network element when there are competing requests for resources such as bandwidth and buffer space. In the packet forwarding path, differentiated services are identified by mapping the differentiated services code point (DSCP) contained in the IP packet header to a specific forwarding behavior at each network element along its path. The DSCP is 6 bits wide, and takes the form *xxxxxx*, where *x* can be either 0 or 1. The DSCP field is capable of identifying one of 64 distinct code points. For purposes of code point allocation and management, the code point space is divided into three pools: one pool of 32 code points (pool 1) constitutes the recommended code points to be allocated as standards; a second pool of 16 code points (pool 2) is set aside for experimental or local use; a third pool of 16 code points (pool 3) that are initially set aside for experimental or local use, but that might be used for standard assignments if pool 1 is ever exhausted. The mapping of DSCPs to PHBs is a user-configurable function, as described below.

The current standards call for two PHBs: Assured Forwarding (AF) and Expedited Forwarding (EF). The EF PHB describes the required behavior for voice-over-IP service. The AF PHB consists of four independently forwarded AF classes: AF1, AF2, AF3, and AF4. Within each of these classes, an IP packet can be assigned to different levels of drop precedence (used to determine drop probability) depending on how many levels of drop precedence the implementation supports. RFC 2597 describes two schemes for drop-precedence levels: a three-level scheme (see Table 3-9) and a two-level scheme (see Table 3-10). The three-level scheme supports low, medium, and high drop-precedence levels for the AF classes; the two-level scheme supports low and high drop-precedence levels (and groups the medium drop-precedence code-points with the high drop-precedence code-points). The Extreme implementation for the PoS module supports the two-level drop-precedence scheme.

Table 3-9: Assured Forwarding Classes and Three-Level Drop Precedence

Drop-Precedence Level	AF1	AF2	AF3	AF4
Low drop precedence	(AF11) 001010	(AF21) 010010	(AF31) 011010	(AF41) 100010
Medium drop precedence	(AF12) 001100	(AF22) 010100	(AF32) 011100	(AF42) 100100
High drop precedence	(AF13) 001110	(AF23) 010110	(AF33) 011110	(AF43) 100110

Table 3-10: Assured Forwarding Classes and Two-Level Drop Precedence

Drop-Precedence Level	AF1	AF2	AF3	AF4
Low drop precedence	(AF11) 001010	(AF21) 010010	(AF31) 011010	(AF41) 100010
High drop precedence	(AF12) 001100	(AF22) 010100	(AF32) 011100	(AF42) 100100
	(AF13) 001110	(AF23) 010110	(AF33) 011110	(AF43) 100110

In addition, a network element that complies with the DiffServ standards must also provide a recommended *default* code point, which must be unique for code points in the standard space. The default PHB describes the common, best-effort forwarding behavior offered by existing network elements, as defined in RFC 1812.

As an additional differentiation, a set of code points has been allocated for use as the Class Selector code points, which describe the minimum forwarding handling requirements needed to preserve compatibility with existing practices while respecting flexibility for the future.

Table 3-11 and the command examples that follow show how the standard per-hop behaviors (PHBs) might be mapped onto ExtremeWare QoS profiles qp1 through qp8.

Table 3-11: Mapping PHBs to QoS Profiles

PHB	Default	Class Selector		AF1	AF2	AF3	AF4	EF
QoS Profile	qp1	qp2	qp3	qp4	qp5	qp6	qp7	qp8
DSCP	000000	001000 010000 011000 100000 101000	110000 111000	001010 001100 001110	010010 010100 010110	011010 011100 011110	100010 100100 100110	101110

The DSCPs associated with a PHB are assigned to the appropriate QoS profile using the `config diffserv examination code-point` command. For example, the following command sets up the mapping for the EF PHB:

```
config diffserv examination code-point 46 qosprofile qp8 ports 2:1-2:2
```

Additional configuration steps for SONET ports in this example are as follows:

- Enable RED for all PHBs except the EF PHB. For example:

  ```
  enable red ports 2:1-2:2
  disable red ports 2:1-2:2 queue 8
  ```

- Configure a high drop-probability of 20% on the SONET ports. For example:

  ```
  config red high-drop-probability 20 ports 2:1-2:2
  ```

- Enable examination of DiffServ information. For example:

  ```
  enable diffserv examination ports 2:1-2:2
  ```

- Configure the default PHB. For example:

  ```
  config diffserv examination code-point 0 qosprofile qp1 ports 2:1-2:2
  ```

- Configure the Class Selectors. For example:

  ```
  config diffserv examination code-point 8 qosprofile qp2
     ports 2:1-2:2 high-drop-probability
  config diffserv examination code-point 16 qosprofile qp2
     ports 2:1-2:2 high-drop-probability
  config diffserv examination code-point 24 qosprofile qp2
     ports 2:1-2:2 high-drop-probability
  config diffserv examination code-point 32 qosprofile qp2
     ports 2:1-2:2 low-drop-probability
  config diffserv examination code-point 40 qosprofile qp2
     ports 2:1-2:2 low-drop-probability
  config diffserv examination code-point 48 qosprofile qp3
     ports 2:1-2:2 high-drop-probability
  config diffserv examination code-point 56 qosprofile qp3
     ports 2:1-2:2 low-drop-probability
  ```

- Configure the drop-probability for the DSCPs assigned to AF1 through AF4.

  For example, for AF1 (qp4):

  ```
  config diffserv examination code-point 10 qosprofile qp4
     ports 2:1-2:2 low-drop-probability
  config diffserv examination code-point 12 qosprofile qp4
     ports 2:1-2:2 high-drop-probability
  ```

```
config diffserv examination code-point 14 qosprofile qp4
   ports 2:1-2:2 high-drop-probability
```

For example, for AF2 (qp5):

```
config diffserv examination code-point 18 qosprofile qp5
   ports 2:1-2:2 low-drop-probability
config diffserv examination code-point 20 qosprofile qp5
   ports 2:1-2:2 high-drop-probability
config diffserv examination code-point 22 qosprofile qp5
   ports 2:1-2:2 high-drop-probability
```

For example, for AF3 (qp6):

```
config diffserv examination code-point 26 qosprofile qp6
   ports 2:1-2:2 low-drop-probability
config diffserv examination code-point 28 qosprofile qp6
   ports 2:1-2:2 high-drop-probability
config diffserv examination code-point 30 qosprofile qp6
   ports 2:1-2:2 high-drop-probability
```

For example, for AF4 (qp7):

```
config diffserv examination code-point 34 qosprofile qp7
   ports 2:1-2:2 low-drop-probability
config diffserv examination code-point 36 qosprofile qp7
   ports 2:1-2:2 high-drop-probability
config diffserv examination code-point 38 qosprofile qp7
   ports 2:1-2:2 high-drop-probability
```

- Configure the congested-state mappings for DSCPs 10 (AF11), 18 (AF21), 26 (AF31), and 34 (AF41). For example:

```
config diffserv dscp-mapping 10/12 egress congestion
config diffserv dscp-mapping 18/20 egress congestion
config diffserv dscp-mapping 26/28 egress congestion
config diffserv dscp-mapping 34/36 egress congestion
```

- Use the EF PHB to configure bandwidth reservation and rate limiting. For example:

```
config diffserv examination code-point 46 qosprofile qp8 ports 2:1-2:2
config qosprofile qp8 minbw 10 maxbw 20 2:1-2:2 egress
config qosprofile qp8 minbw 10 maxbw 20 2:1-2:2 ingress
```

Displaying RED Configuration Information for PoS Module Ports

While the syntax of the existing `show ports info detail` command has not changed, the output of the command now displays the RED and DiffServ configuration parameters associated with PoS module ports.

To display QoS, RED, and DiffServ information for a specified PoS port, use the following command:

```
show ports info detail
```

For PoS ports, the existing `show ports qosmonitor` *command has also been enhanced to display the number of packet transmissions and discards from each queue (in both egress and ingress directions).*

QoS Monitor

The QoS Monitor utility is supported for PoS module ports. The QoS Monitor and its associated ExtremeWare commands are described in the *ExtremeWare Software User Guide*.

Intra-Subnet QoS

Intra-Subnet QoS (ISQ) is not supported on switches that use the "*i*" chipset; the PoS module is supported only on switches that use the "*i*" chipset.

Configuring and Monitoring Flow Statistics

Each PoS port can maintain and export traffic statistics for the flows that traverse the associated SONET link. A flow is defined as a unidirectional sequence of packets between a particular source device and destination device that share the same protocol and transport-layer information. Flows are defined by the following fields: source IP address, destination IP address, source port, destination port, protocol type, and SONET interface. Per-flow statistics are useful for many management purposes, including:

- Accounting and billing
- Network capacity planning and trend analysis
- Network monitoring
- Workload characterization
- User profiling
- Data warehousing and mining

Flow Statistics Background Information

Each PoS module can maintain two million flow records. Per-flow statistics are exported in the NetFlow Version 1 record format described in Table 3-12. NetFlow records are unidirectional in nature, which implies that two flow records are maintained for a typical TCP connection: one record for flow in the ingress direction; a second for the flow in the egress direction. Also, records are maintained only for TCP and UDP flows.

Table 3-12: NetFlow Version 1 Record Format

Field Name	Octets	Field Description
srcaddr	4	Source IP address
dstaddr	4	Destination IP address
nexthop	4	IP address of next-hop router; set to zero for per-flow statistics; set to xFFFF for filter-based aggregated statistics
input	2	Input interface index; set to index of PoS interface for ingress flows received from the SONET link; set to zero for egress flows that are being transmitted over the SONET link
output	2	Output interface index; set to index of PoS interface for egress flows that are being transmitted over the SONET link; set to zero for ingress flows received from the SONET link

Table 3-12: NetFlow Version 1 Record Format (continued)

Field Name	Octets	Field Description
dPkts	4	Number of packets sent in this flow
dOctets	4	Number of octets sent in this flow
First	4	SysUptime when flow record was created
Last	4	SysUptime at most-recent, or last packet of flow
srcport	2	Source port number, valid only for TCP and UDP flows
dstport	2	Destination port number, valid only for TCP and UDP flows
pad	2	Unused field
prot	1	Number identifying the IP protocol; for example, 6=TCP and 17=UDP
tos	1	IP Type-of-Service (TOS) field value from initial packet that caused this flow record to be created
tcp_flags	1	Cumulative OR of TCP flags field, valid only when *prot*=6
pad	11	Unused field

Flow records are grouped together into UDP datagrams for export to a flow-collector device. A NetFlow Version 1 export datagram can contain up to 25 flow records. Figure 3-9 shows the format of the export datagram; Table 3-13 describes the export datagram header.

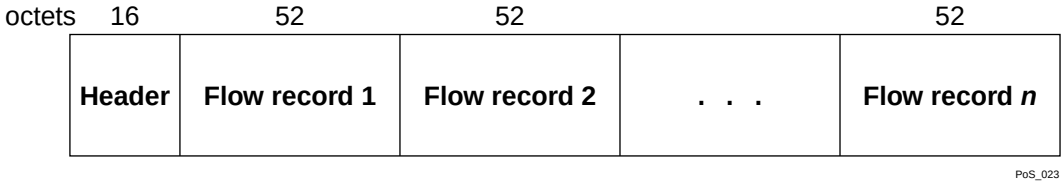


Figure 3-9: Format of NetFlow export datagram

Table 3-13: Format of NetFlow Version 1 Export Datagram Header

Field Name	Octets	Field Description
version	2	Header version=1.
count	2	Number of flow records in datagram.
SysUptime	4	Current time in milliseconds since the switch booted.
unix_secs	4	Current count of seconds since 0000 UTC 1970.
unix_nsecs	4	Current count of residual nanoseconds since 0000 UTV 1970.

The IP addresses (or hostnames) and UDP port numbers of the available flow collectors can be configured on a per-switch basis. The flow collection architecture example in Figure 3-10 illustrates how multiple BlackDiamond switches might export flow records to flow-collector devices that, in turn, feed records into a central collector-server. Other flow-collector architectures are also possible. For example, each SONET port might export statistics to a dedicated flow-collector device.

The ExtremeWare NetFlow implementation for the PoS module also enables a single SONET port to distribute statistics across multiple groups of flow-collector devices. This NetFlow distribution feature enables a scalable collection architecture that is able to accommodate high volumes of exported data. The NetFlow distribution feature is enabled by configuring *export distribution groups* that contain the addresses of multiple flow-collector devices. The feature uses a distribution algorithm that ensures all of the records for a given flow are exported to the same collector. The algorithm also ensures that the flow records for both the ingress and egress directions of a TCP or UDP connection are exported to the same collector when both flows traverse the SONET link and both filters are configured to export to the same group. For example, a potentially different group can be associated with a filter. The flow records that match the filter are then sent to one of the flow collector devices in that group. You could also establish redundancy by allowing multiple flow collector devices per group so that data is still collected as long as there is one working flow collector device in that group.

To implement flow-collector devices, you can choose from commercial software products and public-domain software packages.

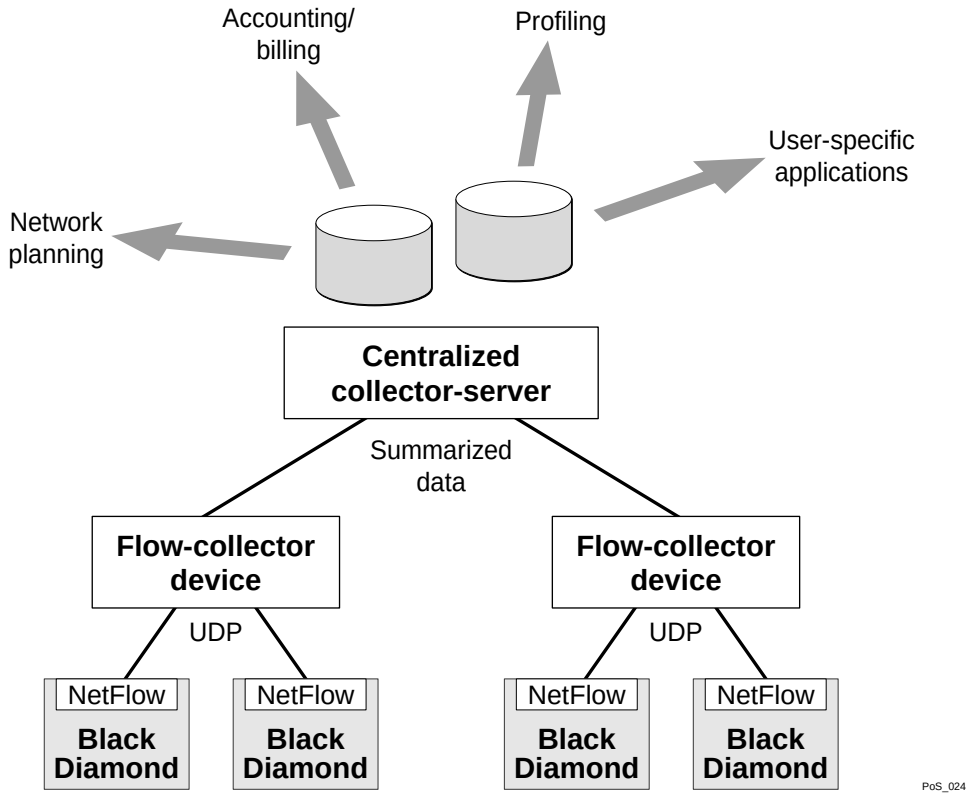


Figure 3-10: NetFlow Collection Architecture Example

Collection Port and Filtering Options

By default, each PoS port maintains statistics for all the flows traversing the SONET link in both the ingress and egress directions. However, generalized filtering options exist that enable a port to maintain statistics only for ingress flows, only for egress flows, or only for selected ingress and/or egress flows.

You can use these filtering options to configure a PoS port to maintain statistics selectively for only those flows that match a specified filter. Up to 16 filters are supported for each PoS port: eight filters for ingress flows; eight filters for egress flows. The filters consist of a {*value,mask*} pair for each of the following flow components: destination IP address, source IP address, destination port, source port, and protocol. Conceptually, the filters work by logically ANDing the contents of each of these five

components of a forwarded flow with the associated *masks* from the first filter. Statistics are maintained if the results of the AND operations match the configured filter values for all fields of the five flow components. If there is not a match on all fields of the five components, then the operation is repeated for the second filter, and so on. If there is no match for any of the filters, then statistics are not maintained for the flow.

Collection Architecture Scalability and Reliability

By supporting statistics distribution across groups of flow-collector devices, the NetFlow distribution function enables a scalable collection architecture that is able to accommodate high volumes of exported data. The function also includes a health-check feature that significantly improves the reliability of the collection architecture. The health-checker ensures that only responsive flow-collector devices are included in the effective export distribution lists.

Up to 32 export distribution groups can be configured on a Black Diamond 6800 series switch. Each of these groups can contain the addresses of up to eight flow-collector devices. A particular export group can then be specified for each filter, which provides a high-degree of flexibility.

A filter-based aggregation capability is also offered to further enhance scalability. Each filter can be configured to be either a *per-flow filter* or an *aggregation* filter. When a flow matches a filter that is configured as an aggregation, normal per-flow statistics are not maintained for the flow. Instead, a single set of statistics is maintained for all the flows that match the aggregation filter, which can substantially reduce the volume of exported data.

Aggregated flow statistics are also exported in the NetFlow Version 1 format. The *nexthop* field of the flow record (see Table 3-12) is set to xFFFF to indicate that the record is associated with a filter-based aggregation. The *srcaddr*, *dstaddr*, *srcport*, *dstport*, and *prot* fields of an aggregated flow record are set to the corresponding value components of the associated filter specification.

Export Criteria

TCP flow records are exported when the associated connection is terminated. Flow records are also exported on an age basis. All flow records, including aggregation records, are examined at least once every 30 minutes. If the age of the flow is greater than a configurable time, the record is exported. If the flow is still active, a new flow record will be created when the next packet arrives.

The PoS module transmits a NetFlow Export Datagram when 25 flow records are ready for export, or when at least one flow has been awaiting export for one second.

Commands for Configuring and Monitoring Flow Statistics

Table 3-14 is an alphabetical list of the ExtremeWare flow statistics commands that support the PoS module. Each command is described in detail in the sections that follow.

Table 3-14: Flow Statistics Commands

Command	Description
config flowstats export {<group#>} [add | delete] [<ipaddress> | <hostname>] <udp_port>	Configures the flow-collector devices to which NetFlow datagrams are exported.
config flowstats filter <filter#> {aggregation} {export <group#>} ports <portlist> [ingress | egress] <filterspec>	Configures a flow record filter for the specified SONET ports.
config flowstats source ipaddress <ipaddress>	Configures the IP address that is to be used as the source IP address for NetFlow datagrams to be exported.
config flowstats timeout <minutes> ports <portlist>	Configures the timeout value for flow records on the specified SONET ports.
disable flowstats filter <filter#> ports <portlist> [ingress | egress]	Disables a specified flow record filter for the specified SONET ports.
disable flowstats ping-check {<group#>}	Disables the flow statistics ping-check function for a specified group of collector devices.
disable flowstats ports <portlist>	Disables the flow statistics function on the specified SONET ports.
enable flowstats filter <filter#> ports <portlist> [ingress | egress]	Enables a specified flow record filter for the specified SONET ports.
enable flowstats ping-check {<group#>}	Enables the flow statistics ping-check function for a specified group of collector devices.
enable flowstats ports <portlist>	Enables the flow statistics function on the specified SONET ports.
show flowstats {<portlist> | export {<group#>} {detail}}	Displays status information for the flow statistics function.
unconfig flowstats ports <portlist>	Resets the flow statistics configuration parameters for the specified SONET ports to their default values.

Enabling and Disabling Flow Statistics

To enable the flow statistics function on the specified SONET port, use the following command:

```
enable flowstats ports <portlist>
```

The flow statistics function is disabled by default.

Flow statistics are collected only on SONET ports that are configured to use the IP Control Protocol (IPCP). No flow statistics are collected on ports that are configured to use the Bridging Control Protocol (BCP). You will not be prevented from enabling the flow statistics function on ports not configured for IPCP, but statistics will not be collected on those ports.

To disable the flow statistics function on the specified SONET port, use the following command:

```
disable flowstats ports <portlist>
```

The flow statistics function is disabled by default.

Configuring the Export Destination

A single SONET port can distribute statistics across multiple groups of flow-collector devices. This NetFlow distribution capability makes it possible to create a collection architecture that scales to accommodate high volumes of exported data. It also offers a health-checking function that improves the reliability of the collection architecture by ensuring that only responsive flow-collector devices are included in active export distribution lists.

The distribution algorithm ensures that all the records for a given flow are exported to the same collector. The algorithm also ensures that flow records for both the ingress and egress directions of a TCP or UDP connection are exported to the same collector (when both flows traverse the same SONET link and both filters are configured to export to the same group).

NetFlow distribution is enabled by configuring export distribution groups that identify the addresses of multiple flow-collector devices. You can configure up to 32 export distribution groups on a BlackDiamond 6800 series switch, and each group can contain as many as eight flow-collector devices.

To configure the export groups and flow-collector devices to which NetFlow datagrams are exported, use the following command:

```
config flowstats export {<group#>} [add | delete]
   [<ipaddress> | <hostname>] <udp_port>
```

The optional `group#` parameter is an integer in the range from 1 through 32 that identifies the specific group for which the destination is being configured. If you do not specify a value for the `group#` parameter, the parameter value defaults to 1.

You can use the `add` and `delete` keywords to add or delete flow-collector destinations.

To export NetFlow datagrams to a group, you must configure at least one flow-collector destination. By default, no flow-collector destinations are configured. To configure a flow-collector destination, use either an IP address and UDP port number pair or a hostname and UDP port number pair to identify the flow-collector device to which NetFlow export datagrams are to be transmitted. You can configure up to eight flow-collector destinations for each group. When multiple flow-collectors are configured as members of the same group, the exported NetFlow datagrams are distributed across the available destinations.

Configuring the Source IP Address

To configure the IP address that is to be used as the source IP address for NetFlow datagrams to be exported, use the following command:

```
config flowstats source ipaddress <ipaddress>
```

No NetFlow datagrams are exported until the source IP address is configured. Depending on how it is configured, a flow-collector device can use the source IP address of received NetFlow datagrams to identify the switch that sent the information.

The configured IP address should be associated with a VLAN that has loopback-mode enabled.

The following command example specifies that the IP address 192.168.100.1 is to be used as the source IP address for exported NetFlow datagrams.

```
config flowstats source ipaddress 192.168.100.1
```

Configuring Flow Record Timeout

Flow records are exported on an age basis: All flow records are examined at least once every 30 minutes. If the age of the flow record is greater than the configured timeout, the record is exported. If the flow is still active, a new flow record will be created when the next packet arrives.

To configure the timeout value for flow records on the specified SONET port, use the following command:

```
config flowstats timeout <minutes> ports <portlist>
```

The timeout value is the number of minutes to use in deciding when to export flow records. The number is an integer in the range from 1 to 1440. The default timeout is 5 minutes.

The following command example specifies a 10-minute timeout for exported NetFlow datagrams on port 1 of the PoS module installed in slot 8 of the BlackDiamond switch.

```
config flowstats timeout 10 ports 8:1
```

Configuring a Flow Record Filter

You can configure a SONET port to maintain statistics selectively for only those flows that match a specified filter. Each port on an PoS module supports 16 filters: eight filters for ingress flows; eight filters for egress flows.

To configure a flow record filter for the specified SONET port, use the following command:

```
config flowstats filter <filter#> {aggregation} {export <group#>}
   ports <portlist> [ingress | egress] <filterspec>
```

where:

`filter#`	The `filter#` parameter is an integer in the range from 1 to 8 that operates with either the `ingress` or `egress` keyword to identify the filter that is being defined.
`aggregation`	To reduce the volume of exported data, use this optional keyword to maintain a single set of statistics for all the flows that match the specified filter.

`export <group#>` — To specify a particular export distribution group on a per-filter basis, use the optional `export` keyword with a group number value to identify the set of flow collector devices to which records for flows matching the filter are to be exported. If you do not specify a value for `group#`, the value defaults to 1.

`ingress` — Use this keyword to specify that the filter being defined in the command is one of the eight filters to be applied to ingress flows.

`egress` — Use this keyword to specify that the filter being defined in the command is one of the eight filters to be applied to egress flows.

`filterspec` — Each filter is defined using a *value*/*filtermask* pair for each of the five components in the following sequence:

```
{destination IP address, source IP address,
destination port number,
source port number, protocol}
```

in the form:

```
[{dest-ip <ipaddress_value/ipaddress_filtermask>}
{source-ip <ipaddress_value/ipaddress_filtermask>}
{dest-port <port_value/port_filtermask>}
{source-port <port_value/port_filtermask>}
{protocol <protocol_value/protocol_filtermask>} |
match-all-flows | match-no-flows]
```

The `ipaddress_filtermask`, `port_filtermask`, and `protocol_filtermask` parameters are configured using hexadecimal notation.

You can also use either the `match-all-flows` keyword or the `match-no-flows` keyword in place of settings for the five components. The `match-all-flows` keyword adjusts the *value*/*filtermask* settings for all the components to 0/0 such that the filter matches any flow. The `match-no-flows` keyword adjusts the *value*/*filtermask* settings for all the components such that the filter does not match any flow.

By default, filter #1 is configured to `match-all-flows`, and the remaining filters are configured to `match-no-flows`.

Conceptually, the filters work by ANDing the contents of each of the five components of a forwarded flow with the associated masks from the first defined filter (filter #1). Statistics are maintained if the results of the AND operations match the configured filter values for all fields of the sequence. If there is no match, then the operation is repeated for filter #2, and so on. If there is no match for any of the filters, then statistics are not maintained for the flow. Filters for any or all of the sequence components can be configured with a single command.

The following command example configures a filter to collect statistics on ingress flows destined for 192.168.1.1 from the 192.169.0.0/16 subnet with a destination port of 80 using protocol 6.

```
config flowstats filter 1 export 1 ports all ingress
   dest-ip 192.168.1.1/FFFFFFFF source-ip 192.169.0.0/FFFF0000
   dest-port 80/FFFF source-port 0/0 protocol 6/FF
```

Likewise, the following command example configures a filter to collect statistics on egress traffic from the 192.168.0.0/16 subnet to 192.169.1.1 with a destination port of 80 using protocol 6.

```
config flowstats filter 1 export 1 ports all egress
   dest-ip 192.169.1.1/FFFFFFFF source-ip 192.168.0.0/FFFF0000
   dest-port 80/FFFF source-port 0/0 protocol 6/FF
```

The following command example configures a filter to collect aggregate statistics for all egress traffic flowing from the 192.170.0.0/16 subnet to the 192.171.255.255 subnet.

```
config flowstats filter 2 aggregation export 1 ports all egress
   dest-ip 192.171.0.0/FFFF0000 source-ip 192.170.0.0/FFFF0000
   dest-port 0/0 source-port 0/0 protocol 0/0
```

Likewise, the following command example configures a filter to collect aggregate statistics for all ingress traffic flowing from the 192.171.0.0/16 subnet to the 192.170.0.0/16 subnet.

```
config flowstats filter 2 aggregation export 1 ports all ingress
   dest-ip 192.170.0.0/FFFF0000 source-ip 192.171.0.0/FFFF0000
   dest-port 0/0 source-port 0/0 protocol 0/0
```

Finally, the following command examples configure two filters—an egress filter and an ingress filter— to collect statistics on any remaining flows that did not match the ingress and egress filters defined in the four previous command examples.

```
config flowstats filter 3 export 1 ports all egress match-all-flows
config flowstats filter 3 export 1 ports all ingress match-all-flows
```

Enabling and Disabling a Flow Record Filter

To enable a specified flow record filter for the specified SONET port, use the following command:

```
enable flowstats filter <filter#> ports <portlist> [ingress | egress]
```

By default, filter #1 is enabled on all SONET ports for both ingress and egress flows, and all remaining filters are disabled.

To disable a specified flow record filter for the specified SONET port, use the following command:

```
disable flowstats filter <filter#> ports <portlist> [ingress | egress]
```

where:

`filter#`	The `filter#` parameter is an integer in the range from 1 to 8 that operates with either the `ingress` or `egress` keyword to identify the filter that is being enabled or disabled.
`ingress`	Use this keyword to specify that the filter being enabled or disabled is one of the eight filters to be applied to *ingress* flows.
`egress`	Use this keyword to specify that the filter being enabled or disabled is one of the eight filters to be applied to *egress* flows.

The following command example enables ingress filter #2 on port 1 of the PoS module installed in slot 8 of the BlackDiamond switch.

```
enable flowstats filter 2 ports 8:1 ingress
```

The following command example disables ingress filter #2 on port 1 of the PoS module installed in slot 8 of the BlackDiamond switch.

```
disable flowstats filter 2 ports 8:1 ingress
```

Enabling and Disabling Flow Statistics Ping-Check

To enable the flow statistics ping-check function for a specified group of collector devices, use the following command:

```
enable flowstats ping-check <group#>
```

If you do not specify a value for the `group#` parameter, the ping-check function is enabled for all collector groups.

The ping-check function is enabled by default.

When the ping-check function is enabled, each of the flow collector devices is pinged periodically to check its network connectivity. If a flow collector device is repetitively unresponsive, it is temporarily removed from the export distribution list for that group. The flow collector device will be returned to the export distribution list automatically when subsequent ping checks are consistently successful.

The following command example enables the ping-check function for export group 2.

```
enable flowstats ping-check 2
```

To disable the flow statistics ping-check function for a specified group of collector devices, use the following command:

```
disable flowstats ping-check <group#>
```

If you do not specify a value for the `group#` parameter, the ping-check function is disabled for all collector groups.

The following command example disables the ping-check function for export group 2.

```
disable flowstats ping-check 2
```

Unconfiguring Flow Statistics

To reset the flow statistics configuration parameters for a specified SONET port to their default values, use the following command:

```
unconfig flowstats ports <portlist>
```

This command does not affect the enabled or disabled status of flow statistics collection, nor does it affect the configured export destinations.

The following command example resets the flow statistics configuration parameters for port 1 of the PoS module installed in slot 8 of the BlackDiamond switch to their default values.

```
unconfig flowstats ports 8:1
```

Displaying Flow Statistics Status Information

To display status information for the flow statistics function, use the following command:

```
show flowstats {<portlist> | export {<group#>} {detail}}
```

where:

`portlist`	Use this optional parameter to specify the SONET port for which status information is to be displayed.
`export`	Use this optional keyword to display status information for export groups, which are configured on a switch-wide basis.
`group#`	Use this optional parameter with the `export` keyword to display status information for a specific export group. If you do not specify a value for the `group#` parameter, the `export` keyword by itself displays status information for all export groups.
`detail`	Use this optional keyword to display detailed export group status information.

If you enter the `show flowstats` command with none of the optional keywords or parameters, the command displays a summary of status information for all ports.

The summary status display for a port includes the following information:

- Values for all flow statistics configuration parameters
- Count of flow records that have been exported
- Counts of the number of packets/bytes for which flow statistics were not maintained because of insufficient resources

The summary status display for an export group includes the following information:

- Values for all configuration parameters
- Status of each export destination device

The detailed status display for an export group includes the summary information, plus the following management information:

- Counts of the flow records that have been exported to each flow collector destination
- Counts of the number of times each flow collector destination has been taken out of service due to health-check (ping check) failures

MIB Support for Flow Statistics

Because there are no standard MIBs defined for managing the NetFlow function, Extreme Networks has defined and implemented an enterprise MIB that provides read-only support (GET operations but not SET operations) for NetFlow configuration parameters and status information. Any of the parameters that can be set with the `config flowstats` commands can be accessed using the MIB, and any of the status information displayed by the `show flowstats` command can also be read using the MIB. For more information on the MIB, see Appendix B, "Supported MIBs and Standards."

Configuring and Monitoring APS Functions

Automatic Protection Switching, or APS, is a resiliency feature specified in the SONET standards. Of the different modes of operation defined in the APS specifications, the BlackDiamond 6800 series switch supports the Linear 1+1 APS architecture to protect tributary SONET lines connecting switches to Add-Drop Multiplexers (ADMs). Linear APS can be contrasted with the Ring APS architectures, which protect the lines between the equipment comprising a SONET ring. Figure 3-11 is an example of the Linear 1+1 architecture, where there is one protection line for each working line, and the ADM transmits the same data to both the working line and the protection line.

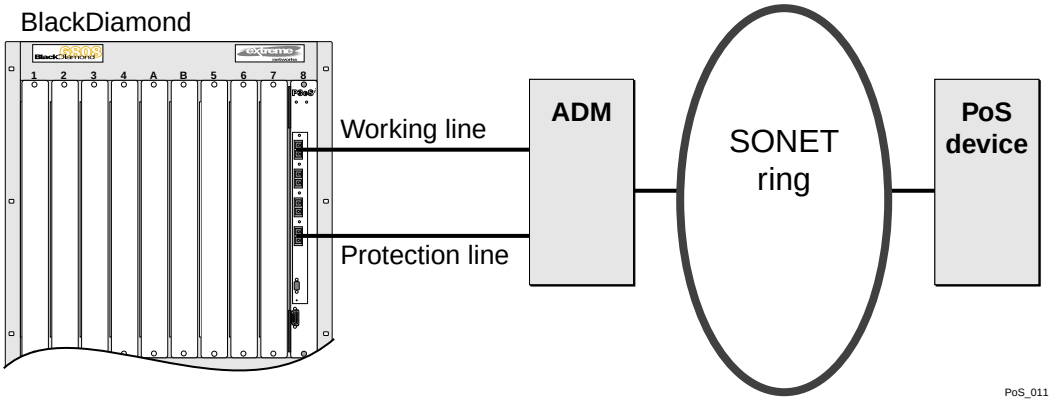


Figure 3-11: Linear 1+1 APS architecture

The APS standards specify both unidirectional and bidirectional-switching modes. In the bidirectional mode, both ends must select, or receive data from, the same line. Thus, switching from one line to another must be coordinated. This synchronization is achieved using APS protocols that are carried in the K1 and K2 bytes of the SONET line overhead. The K1 and K2 bytes must be transmitted on the protection line, and may also be transmitted on the working line; however, receivers cannot assume that the K1 and K2 bytes will be transmitted on the working line.

Bidirectional switching is advantageous for data communication applications where the working line and the protection line are terminated in different switches, as depicted in Figure 3-12. Because the working and protection lines form a single SONET interface with respect to the rest of the network, it is clearly more straightforward and efficient for one switch to handle all the payload transmission and reception responsibilities for

the interface. Consequently, the BlackDiamond 6800 series switch supports bidirectional switching, but not unidirectional switching.

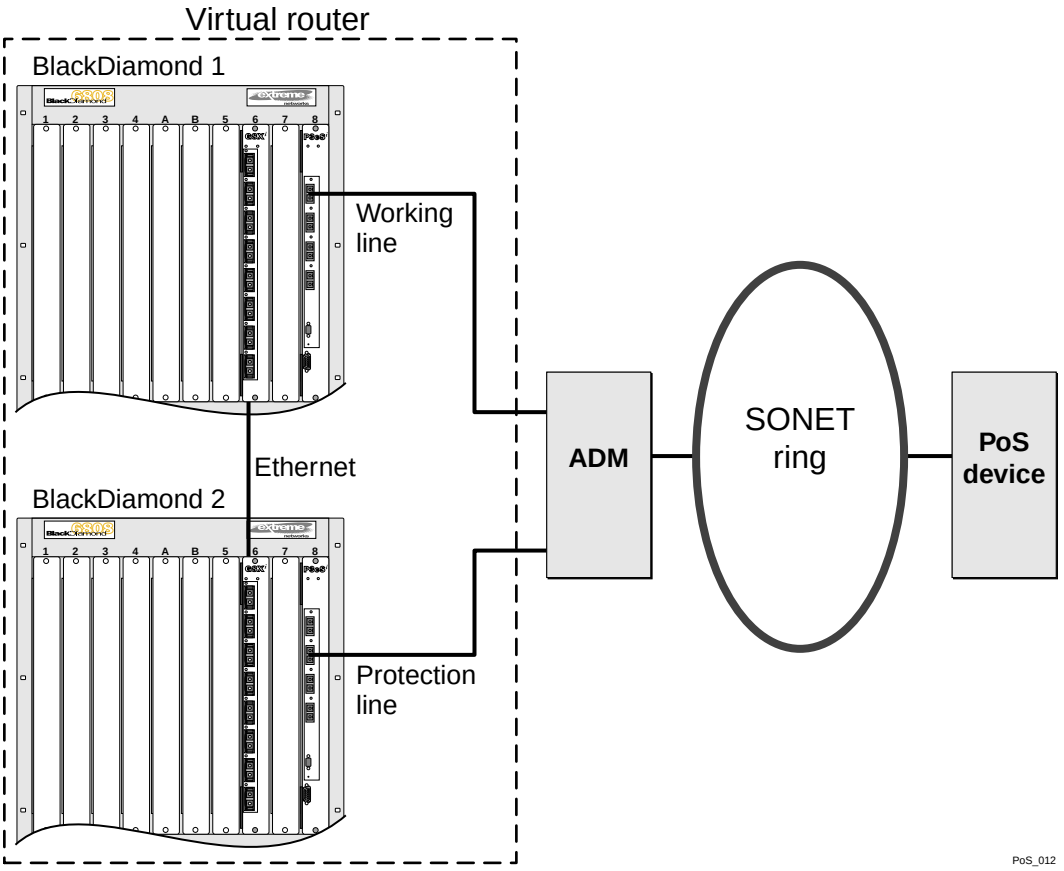


Figure 3-12: Linear 1+1 APS architecture with two switches

The 1+1 architecture can also operate in *revertive* or *nonrevertive* mode, which allows you to determine what action should be taken when traffic is active on the protection line and the working line becomes operational. The BlackDiamond 6800 series switch supports both revertive and non-revertive modes of operation.

In revertive mode, when traffic is active on the protection line and the working line becomes operational, traffic will be switched automatically from the protection line to the working line.

Conversely, in nonrevertive mode, when traffic is active on the protection line and the working line becomes operational, traffic will remain on the protection line (until either manual intervention or a failure on the protection line forces a switch back to the working line).

APS Network Configuration Options

Three basic APS configurations are supported:

- Two-switch configuration, where the working line is terminated in one BlackDiamond switch and the protection line is terminated in another.
- Two-module configuration, where the working line and the protection line are terminated in two different SONET modules that reside in the same BlackDiamond chassis.
- Single-module configuration, where the working line and the protection line are terminated in the same BlackDiamond SONET module.

Because the two-switch configuration is the most advanced, it is discussed first, followed by the two simpler configurations.

In the two-switch configuration (see Figure 3-13), the two BlackDiamond switches form a virtual APS switch. The PoS interface in BlackDiamond #1 is configured to be the working line, while the PoS interface in BlackDiamond #2 is configured to be the protection line. The same IP address is configured for both PoS interfaces. In this example, the common IP address is 192.168.10.1. The use of a common IP address enables the neighboring PPP router to view the virtual APS switch as a single router entity; the neighboring router is unaware that its partner is actually two cooperating switches. Figure 3-14 illustrates the logical PPP connectivity between the virtual APS router and the neighboring PPP router.

Note: The two-switch configuration is supported only if PPP is configured on the PoS ports. The two-switch configuration is not supported if HDLC tunneling is configured on the PoS ports.

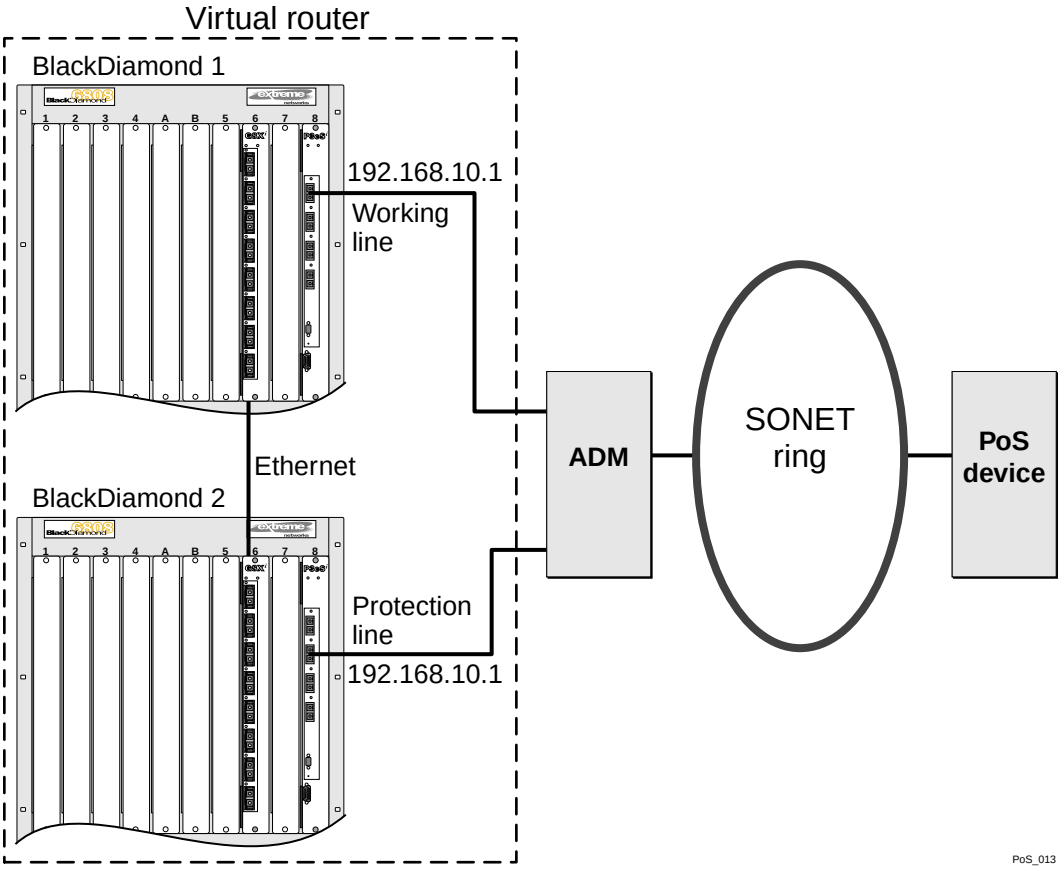


Figure 3-13: Virtual APS router configuration

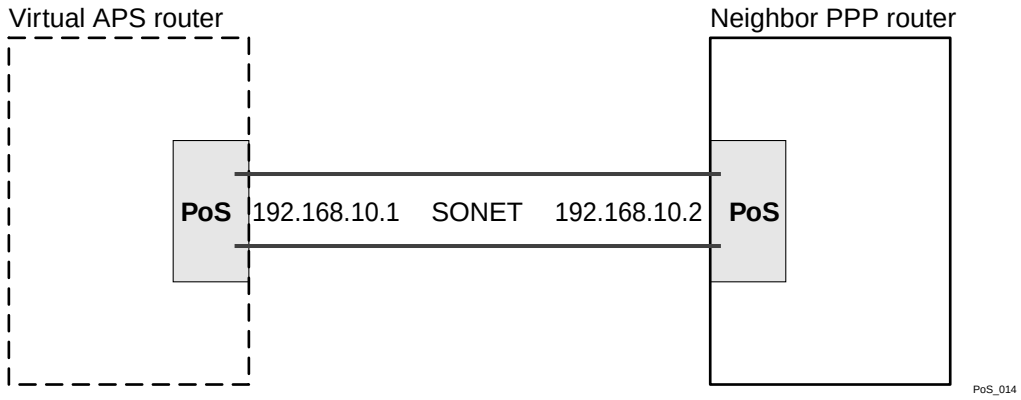


Figure 3-14: Logical PPP connectivity to virtual APS router

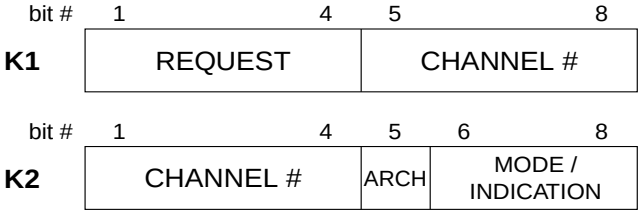
Another important characteristic of the virtual APS router configuration shown in Figure 3-13 is the Ethernet link between BlackDiamond #1 and BlackDiamond #2. This Ethernet link provides an out-of-band communications channel that provides a way for the two switches to synchronize their use of the SONET interfaces. For example, if BlackDiamond #1 detects poor signal quality on the working line, it sends a message over the Ethernet link to BlackDiamond #2, which initiates a switch to the protection line. The Ethernet link is also used to carry heartbeat messages that enable the protection switch to take over if the working switch fails.

The two-module and single-module configurations are similar to the two-switch configuration, except that there is no out-of-band Ethernet communications link. These configurations are simpler, because a single switch manages both the working line and the protection line. One advantage of the simpler single-switch configurations is faster network-recovery times following a line or module failure. The single-module configuration protects against line failures, while the two-module configuration protects against both line and module failures. The two-switch configuration further expands the protection scope to include line, module, and switch failures.

Sample Line-Switching Scenario

In the following sample line-switching scenario, the working router initiates the APS switch to the protection line. In this sample scenario, assume that the working line is active, and that the working router initiates a switch to the protection line upon detecting a signal fail or signal degrade condition on the working line. The working router initiates the line switch by sending a message to the protection router over the

out-of-band Ethernet connection. All APS-related Ethernet communications between the working router and the protection router are via UDP. Upon receiving the message, the protection router invokes the APS protocol to request that the ADM switch to the protection line. The APS protocol is carried in the K1 and K2 bytes of the SONET overhead. The format of the K1 and K2 bytes is illustrated in Figure 3-15.



Legend

REQUEST

0000	No Request
0001	Do Not revert (nonrevertive only)
0010	Reverse Request (bidirectional only)
0100	Excercise
0110	Wait-To-Restore (revertive only)
1000	Manual Switch
1010	Signal Degrade
1100	Signal Fail
1110	Forced Switch
1111	Lockout of Protection

CHANNEL #

K1 - number of channel issuing request (1=>working, 0=>protection)
K2 - 0 if channel # in received K1=0, else channel # bridged to protection line

ARCHITECTURE

0 => provisioned for 1+1 architecture

MODE / INDICATION

100	Provisioned for Unidirectional Switching Mode
101	Provisioned for Bidirectional Switching Mode
110	Line Remote Defect Indication (RDI-L)
111	Line Alarm Indication Signal (AIS-L)

PoS_019

Figure 3-15: Format of SONET K1 and K2 Bytes

Based on the K1 and K2 definitions, Table 3-15 shows the detailed APS protocol exchanges for switching from the working line to the protection line. The example assumes the switch occurs because a Signal Degrade condition is detected on the working line. All APS protocol exchanges occur on the protection line, between the protection router and the ADM.

Table 3-15: APS Protocol for Switch from Working Line to Protection Line

Protect Router → ADM		**ADM → Protect Router**		**Comments**
K1 Byte	**K2 Byte**	**K1 Byte**	**K2 Byte**	
0000 0000	0000 0 101	0000 0000	0000 0 101	No failures; working line active. Example is provisioned for 1+1 architecture and bidirectional switching mode.
1010 0001	0000 0 101	0000 0000	0000 0 101	Protection router receives Signal Degrade message from working router over Ethernet link, and sends Signal Degrade request for channel 1 (the working line) to the ADM.
1010 0001	0000 0 101	0010 0001	0001 0 101	ADM acknowledges the Signal Degrade request by sending Reverse Request for channel 1 in K1; K2 indicates that the ADM has bridged channel 1 to the protection line.
1010 0001	0001 0 101	0010 0001	0001 0 101	Protection router selects (receives) channel 1 data from the protection line based on received K2, and uses K2 to indicate that channel 1 is bridged to the protection line.
1010 0001	0001 0 101	0010 0001	0001 0 101	ADM selects (receives) channel 1 data from the protection line based on received K2.

After the APS line switch has completed, the protection router sends a message to the working router over the Ethernet link. The message indicates that the line switch has been performed. The working router responds by taking down the SONET interface and initiating a routing topology update. Similarly, the protection router brings the SONET interface up and advertises availability of routes accessible via the SONET interface. The neighboring PPP router will think that its partner (which is now the protection router) has renegotiated the link. On the LAN side, packets with destinations accessible via the SONET interface will be forwarded to the protection router. These packets may be forwarded to the protection router as a result of the routing topology updates or the Extreme Standby Router Protocol (ESRP).

APS Benefits

In this section, we examine the benefits provided by APS. A typical redundant switch configuration is illustrated in Figure 3-16. In this scheme, both BlackDiamond switches have two SONET interfaces that are connected to different ADMs. In this configuration, no switch, PoS interface, SONET line, or ADM represents a single point-of-failure. Compare this with the APS configuration depicted in Figure 3-17.

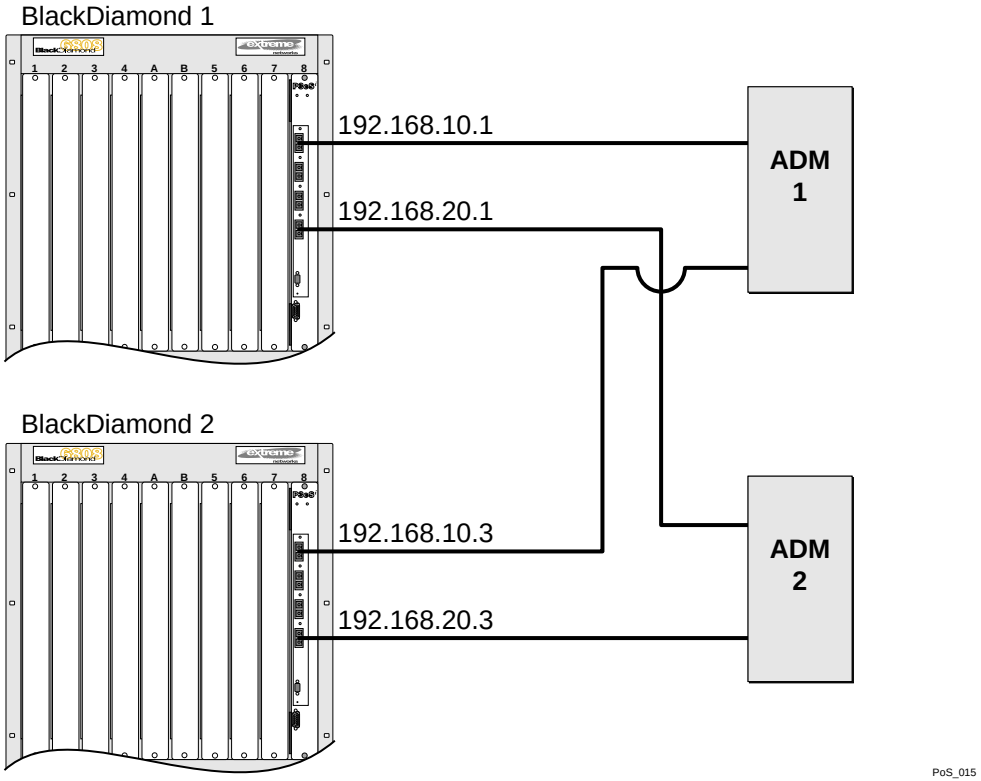


Figure 3-16: Typical redundant switch configuration without APS

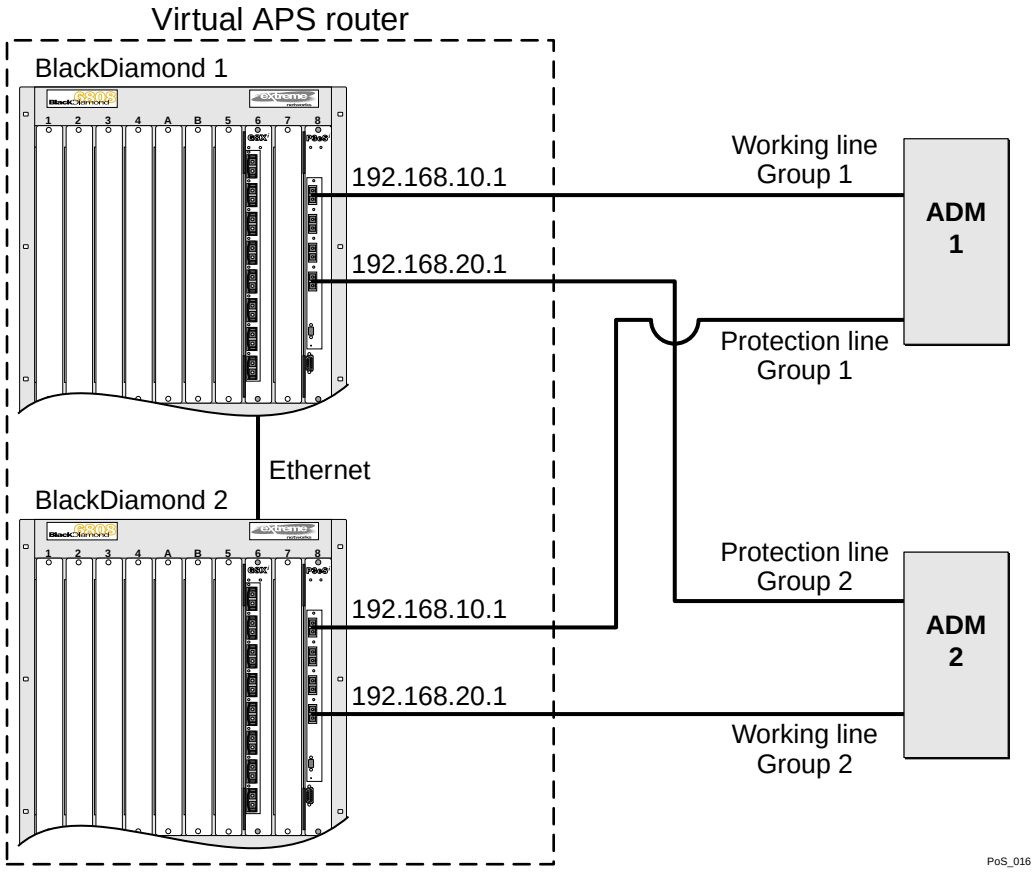


Figure 3-17: Redundant switch configuration with APS

While these two configurations appear similar, the significant difference between them is that the BlackDiamond switches in Figure 3-17 appear to the rest of the network as two PoS interfaces (IP addresses 192.168.10.1 and 192.168.20.1), as opposed to the four PoS interfaces shown in Figure 3-16 (IP addresses 192.168.10.1, 192.168.20.1, 192.168.10.3, and 192.168.20.3). The configuration in Figure 3-17 enables customers to purchase half the SONET bandwidth without sacrificing resiliency. In fact, the APS configuration offers increased resiliency by virtue of not reducing maximum throughput as a result of a single line or switch failure. Furthermore, if the extra bandwidth is needed, two larger bandwidth interfaces are more efficient than four smaller bandwidth interfaces, due to suboptimal load-balancing.

Figure 3-18 shows an APS configuration that provides faster network recovery from SONET line failures or degradations. Recovery is faster in this case because no routing topology updates are needed. Recovery is isolated to the switch and ADM pair connected to the failed line, and consists of performing an APS line switch operation. The downside of the configuration shown in Figure 3-18, relative to Figure 3-17, is that failure of a BlackDiamond switch will reduce the maximum SONET bandwidth by half. Note that failure of an ADM will also halve the maximum available bandwidth in either configuration.

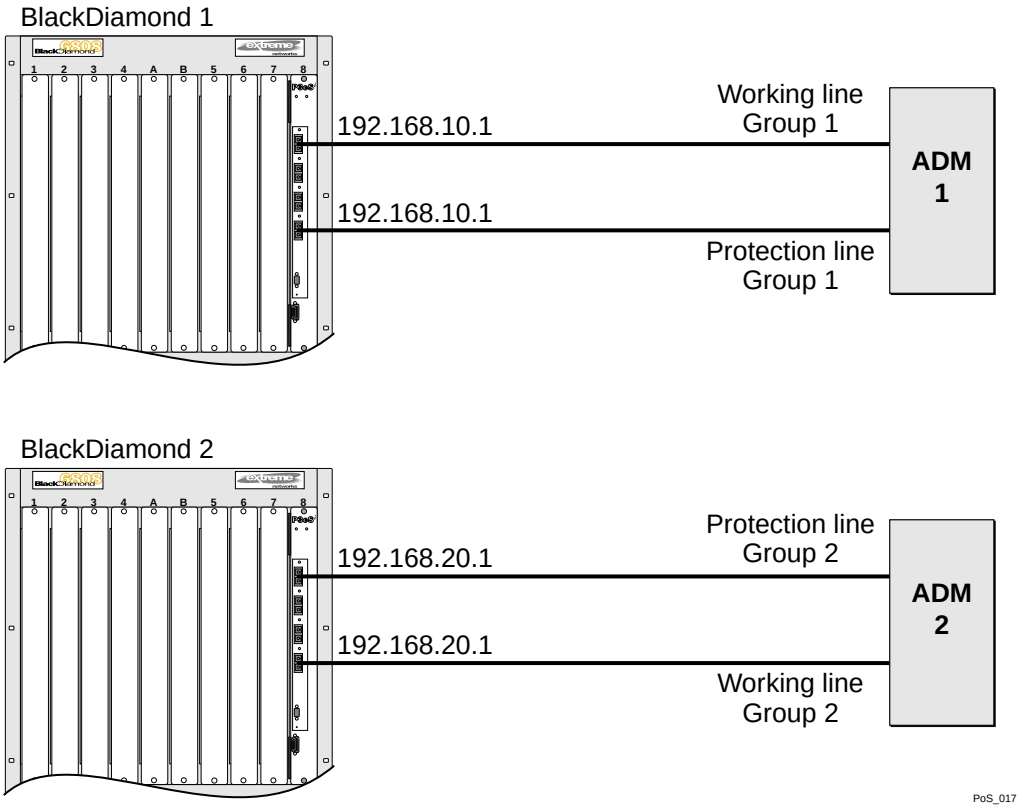


Figure 3-18: APS configuration providing faster recovery from line failure

As mentioned earlier, APS can also be applied to the interconnection of bridges. Figure 3-19 illustrates a configuration where two PoS ports are members of the same VLAN. Assume that, in this example, both PoS ports are configured to run BCP on the common VLAN and bridge traffic for the VLAN across the SONET link. Assigning the two PoS ports to the same APS group improves the resiliency of the bridged network by enabling faster recovery from SONET line failures relative to that achieved by the Spanning Tree Protocol (STP). This recovery is accomplished by simply performing a local APS line switch. Because APS recovers at layer 1, the Spanning Tree Protocol does not need to be informed of the line failure, and therefore, no time-consuming STP reconvergence is necessary.

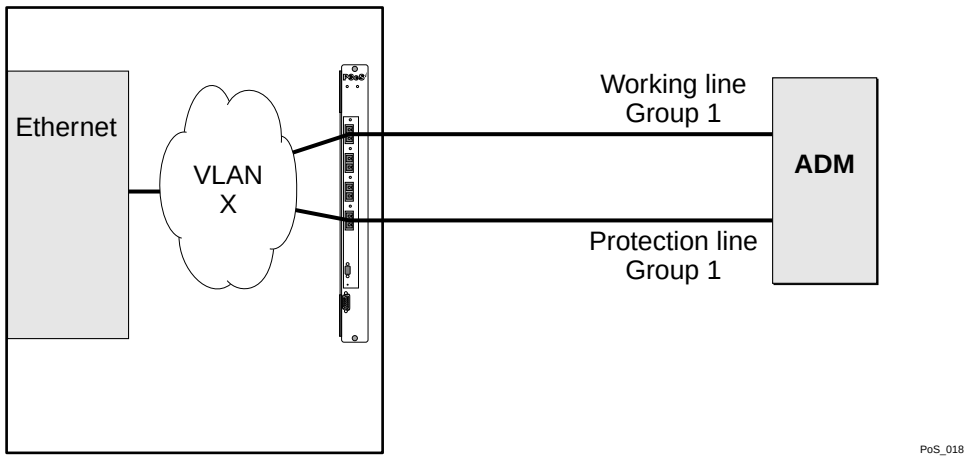


Figure 3-19: APS in bridging configuration

Commands for Configuring and Monitoring APS

Table 3-16 lists the ExtremeWare APS commands that support the PoS module. Each command is described in detail in the sections that follow.

Table 3-16: APS Commands

Command	Description
config aps <group#> [nonrevert | revert <minutes>]	Configures APS operation in either nonrevertive or revertive switching mode.
config aps <group#> add <port> [working | protection <ipaddress>]	Adds a SONET port to an APS group.
config aps <group#> authenticate [off | on <string>]	Configures authentication of APS control messages.
config aps <group#> delete <port>	Deletes a SONET port from an APS group.
config aps <group#> force [off | working | protection]	Requests that an APS group be forced to use a specified line as the active line.
config aps <group#> lockout [off | on]	Controls whether a switch to the protection line is locked out.
config aps <group#> manual [off | working | protection]	Manually determines whether an APS group uses its working line or its protection line as the active line.
config aps <group#> timers <seconds> <consecutive_misses>	Sets the values of the timers used in the APS hello protocol that is exchanged between the working and protection switches for an APS group.
create aps <group#>	Creates an APS group with the specified group number.
delete aps <group#>	Deletes the specified APS group.
disable aps	Disables the APS function for an entire switch.
enable aps	Enables the APS function for an entire switch.
show aps {<group#>} {detail}	Displays APS group status information.
unconfig aps <group#>	Resets the APS group configuration parameters to their default values.

Enabling and Disabling APS

To enable the APS function for the entire switch, use the following command:

```
enable aps
```

To disable the APS function for the entire switch, use the following command:

```
disable aps
```

Creating and Deleting an APS Group

An APS group includes one working line and one protection line. The working line and protection line can reside on the same BlackDiamond switch or on two different BlackDiamond switches. The group is identified by a unique number.

To create an APS group, use the following command:

```
create aps <group#>
```

The `group#` parameter is an integer in the range from 1 through 65535 that identifies the APS group to be created. The APS group numbers must be unique across all BlackDiamond switches that are cooperating to provide the APS function. The group numbers must also be used in a consistent manner across BlackDiamond switches. For example, if the working line is assigned to group #1 on BlackDiamond #1, and the associated protection line resides on BlackDiamond #2, the protection line must also be assigned to group #1 on BlackDiamond #2. The `group#` is used to identify the partner line, which can be either the working line or the protection line, in Ethernet messages exchanged by BlackDiamond switches that are cooperating to provide the APS function.

The following command example creates APS group 1001 on the BlackDiamond switch:

```
create aps 1001
```

To delete an APS group, use the following command:

```
delete aps <group#>
```

The `group#` parameter is an integer in the range from 1 to 65535 that identifies the APS group to be deleted.

The following command example deletes APS group 1001:

```
delete aps 1001
```

Adding a Port to an APS Group

To add a SONET port to an APS group, use the following command:

```
config aps <group#> add <port> [working | protection <ipaddress>]
```

The `group#` parameter is an integer in the range from 1 to 65535 that identifies the APS group to which the specified port is to be added.

The `port` parameter identifies the SONET port that is to be added to the APS group.

You must also specify whether the port is the APS working or protection line. You can add only one working line and one protection line to an APS group. If you designate the port the protection line, then you must also specify the IP address (`ipaddress` parameter) of the BlackDiamond switch where the working line resides. This IP address is used to send APS control messages to the BlackDiamond switch containing the working line.

The configured IP address should be associated with an Ethernet VLAN that has loopback mode enabled to minimize the impact of network outages on APS functionality. Also, when using APS to protect links on different BlackDiamond 6800 series switches, the network connecting the working and protection switches must always have sufficient bandwidth to support APS control transfers.

In routing configurations, the working line and the protection line should represent the same IP address from the perspective of the neighboring PPP switch. When the working line and protection line reside in the same BlackDiamond switch, both ports should be members of the same VLAN. The case where both the working line and the protection line for an APS group reside in the same BlackDiamond switch is the only situation where IPCP can be enabled on multiple SONET ports that are members of the same VLAN. In general, if IPCP is enabled on a PoS module port, that port can be a member of only one VLAN and no other ports on that switch can be members of that VLAN.

The following command example adds port 1 of the module installed in slot 8 of the BlackDiamond switch to APS group 1001 as the working line.

```
config aps 1001 add 8:1 working
```

Deleting a Port from an APS Group

To delete a SONET port from an APS group, use the following command:

```
config aps <group#> delete <port>
```

The group# parameter is an integer in the range from 1 to 65535 that identifies the APS group from which the specified port is to be deleted.

The port parameter identifies the SONET port that is to be deleted from the APS group.

Deleting the working line from an APS group initiates a switch to the protection line, but deleting the active protection line from an APS group does not initiate a switch to the working line.

The following command example deletes port 1 of the module installed in slot 8 of the BlackDiamond switch from APS group 1001.

```
config aps 1001 delete 8:1
```

Configuring APS Authentication

The authentication string is used to validate APS control frames received over an Ethernet link. If authentication fails, the associated APS control frame is discarded.

To configure authentication of APS control messages, use the following command:

```
config aps <group#> authenticate [off | on <string>]
```

The group# parameter is an integer in the range from 1 to 65535 that identifies the APS group to which the authentication command applies.

You must also specify whether authentication is to be turned off or turned on. The default setting is off.

If you are enabling authentication, you must also specify a text authentication string of no more than eight alphanumeric characters as part of the command. If the working line and the protection line for an APS group reside in different BlackDiamond switches, the same authentication string must be configured at both BlackDiamond switches; otherwise, authentication will not work.

The following command example enables APS authentication for group 1001, with “seer5dog” as the authentication string.

```
config aps 1001 authenticate on seer5dog
```

Configuring Nonrevertive or Revertive Mode

You can configure the APS action that should be taken when traffic is active on the protection line and the working line becomes operational.

The default switching mode is nonrevertive switching, which means traffic remains on the protection line until either manual intervention or a failure on the protection line forces a switch back to the working line.

If you configure revertive switching mode on an APS group, traffic is switched automatically from the protection line to the working line after the user-defined Wait-To-Restore (WTR) period. The WTR period minimizes frequent switching due to intermittent errors on the working line by restoring service only when no errors are detected on the working line during the WTR period.

A longer WTR period provides more protection against frequent switching by waiting to assure that the working line is fully operational, but prolongs the time it takes to restore traffic to the working line after it is fully operational.

To configure APS operation in either nonrevertive or revertive switching mode, use the following command:

```
config aps <group#> [nonrevert | revert <minutes>]
```

The `group#` parameter is an integer in the range from 1 to 65535 that identifies the APS group to which the configuration command applies.

The `minutes` parameter is an integer in the range from 0 to 12. If you select revertive switching mode, you must enter a value for `minutes`.

This command applies only to SONET ports performing the protection line function.

The following command example configures APS group 1001 to operate in revertive switching mode, with a WTR of 5 minutes.

```
config aps 1001 revert 5
```

Configuring APS Timers

To set the values of the timers used in the APS hello protocol that is exchanged between the working and protection switches for an APS group, use the following command:

```
config aps <group#> timers <seconds> <consecutive_misses>
```

The `group#` parameter is an integer in the range from 1 to 65535 that identifies the APS group to which this configuration command applies.

The `seconds` parameter is an integer in the range from 1 to 300 that specifies the amount of time the protection switch waits between transmissions of hello packets to the working switch. The default value is 1.

The `consecutive_misses` parameter is an integer in the range from 1 to 100 that controls the time interval the protection switch waits before assuming that the working switch has failed. If the working switch does not respond within `consecutive_misses` hello intervals, or (`consecutive_misses` * `seconds`) seconds, the protection switch assumes that the working switch has failed and initiates a line switch. The default value is 5.

In some cases, even if the working switch and working line are both operational, congestion might temporarily slow the response time of the working switch to the point that the protection switch assumes the working switch has failed, causing premature or unnecessary line switches. While setting larger values for `seconds` *and* `consecutive_misses` *will protect against premature or unnecessary line switches, they can also delay a line switch when an actual switch failure occurs.*

This command applies only to SONET ports performing the protection line function.

The following command example configures the timers for APS group 1001 to 1 second and 3 consecutive misses.

```
config aps 1001 timers 1 3
```

Configuring APS Lockout

You can specify that an APS group operates in lockout mode, which means switches from the working line to the protection line are prohibited until you turn off lockout mode for that APS group. You should use this command when you want to prevent a switchover to the protection line, such as when the protection line is being reprovisioned, repaired, or debugged.

To control whether a switch to the protection line is locked out, use the following command:

```
config aps <group#> lockout [off | on]
```

The `group#` parameter is an integer in the range from 1 to 65535 that identifies the APS group to which the lockout command applies.

By default, lockout mode is off.

This command applies only to SONET ports performing the protection line function. Also, the settings from this command are not preserved when the switch reboots.

The following command example turns on lockout mode for APS group 1001.

```
config aps 1001 lockout on
```

Configuring Forced Switch Mode

You can request that an APS group be forced to use the working line as the active line, or be forced to use the protection line as the active line. Use this command when you plan to perform service on the other link and don't want a switchover to occur.

To request that an APS group be forced to use a specified line as the active line, use the following command:

```
config aps <group#> force [off | working | protection]
```

The `group#` parameter is an integer in the range from 1 to 65535 that identifies the APS group to which the `force` command applies.

The `off` keyword turns off forced switch mode. By default, force switch mode is off.

The working keyword forces the specified APS group to use the working line as the active line. The protection keyword forces the specified APS group to use the protection line as the active line.

A forced switch is a high priority request. Only three events can override a forced switch request:

- A config aps force off command
- A config aps lockout on command (that was either in effect before the force command or issued after the force command)
- A Signal Fail condition detected on the protection line

This command applies only to SONET ports performing the protection line function. Also, the settings from this command are not preserved when the switch reboots.

The following command example forces APS group 1001 to use the protection line as the active line:

```
config aps 1001 force protection
```

Configuring Manual Switch Mode

You can manually determine whether an APS group uses its working line as the active line, or uses its protection line as the active line. One potential use of this capability is to perform a manual switch back to the working line after an error condition has cleared without waiting for the full Wait-To-Restore period to elapse.

To manually determine whether an APS group uses its working line or its protection line as the active line, use the following command:

```
config aps <group#> manual [off | working | protection]
```

The group# parameter is an integer in the range from 1 to 65535 that identifies the APS group to which the command applies.

The off keyword turns off manual switch mode. By default, manual switch mode is off.

The working keyword causes the specified APS group to use the working line as the active line. The protection keyword causes the specified APS group to use the protection line as the active line.

A manual switch is a lower priority request than a forced switch. The following events can override a manual switch:

- A `config aps manual off` command
- A `config aps force working` or a `config aps force protection` command
- A `config aps lockout on` command
- A detected Signal Fail or Signal Degrade line condition

This command applies only to SONET ports performing the protection line function. Also, the settings from this command are not preserved when the switch reboots.

The following command example configures APS group 1001 to use its working line as the active line:

```
config aps 1001 manual working
```

Resetting APS Group Configuration Parameters

To reset the APS group configuration parameters to their default values, use the following command:

```
unconfig aps <group#>
```

The `group#` parameter is an integer in the range from 1 to 65535 that identifies a particular APS group.

This command does not affect the ports that have been added to the APS group, but does cancel any outstanding `lockout`, `force`, *or* `switch` *requests.*

The following command example resets the configuration parameters of APS group 1001 to their default values:

```
unconfig aps 1001
```

Displaying APS Group Status Information

To display APS group status information, use the following command:

```
show aps {<group#>} {detail}
```

The optional `group#` parameter is an integer in the range from 1 to 65535 that identifies a particular APS group for which status is to be shown.

If you enter the `show aps` command without an argument or keyword, the command displays a summary of status information for all configured APS groups. You can use the `detail` keyword to display more detailed status information.

Summary status includes the following information for each APS group:

- Provisioned values of all APS configuration parameters, including SONET port numbers and whether the ports are performing the working or protection line function.
- An indication of whether the line associated with each configured port is active or inactive from an APS perspective, along with a timestamp indicating when the last APS state change occurred.
- An indication of whether an error condition currently exists on the line associated with each configured port, along with a timestamp indicating when the last error occurred (errors include Signal Fail and Signal Degrade Events).
- An indication of whether a Signal Fail (SF) or Signal Degrade (SD) Event due to an excessive Bit Error Rate (BER) currently exists on the line associated with each configured port. The BER thresholds that cause SF and SD Events can be specified as part of configuring a SONET port.
- Counts of the number of SF and SD Events initiated by each configured port due to an excessive BER.
- A count of the number of APS Authentication Failures, which is a count of the number of received APS control packets that have been discarded due to authentication failures.

Detailed status includes the information reported in the summary status along with additional status and management counters. Detailed status only applies to ports performing the protection line function.

Detailed management counters reported for each protection-line port include:

- Automatic line switches initiated by the working-line switch, by the protection-line switch, and by the ADM
- Line switches initiated due to external commands, such as through either the `config aps <group#> force` command or the `config aps <group#> manual` command)
- Line switches completed successfully
- Hello Protocol failures (this count is included as a component of the counter for automatic line switches initiated by the protection-line switch)
- APS mode mismatch failures, which occur when the ADM indicates that it is provisioned for the 1:n APS architecture, or when the ADM indicates that it is provisioned for unidirectional-switching mode
- Protection switching byte failures, which occur when the received K1 byte is either inconsistent or contains an invalid request code
- Channel mismatch failures, which occur when the channel number in the transmitted K1 byte does not match the channel number in the received K2 byte
- Far-end protection line failures, which occur when a Signal Fail request code is received on the protection line

Additional detailed status information reported for each protection-line port includes:

- Current contents of received K1 and K2 bytes
- Contents of K1 and K2 bytes that are currently being transmitted
- Indication of whether an APS Mode Mismatch Failure is currently active
- Indication of whether a Protection Switching Byte Failure is currently active
- Indication of whether a Channel Mismatch Failure is currently active
- Indication of whether a Far-End Protection Line Failure is currently active

MIB Support for APS

Because no standard MIBs are defined for managing the APS function, Extreme Networks has defined and implemented an enterprise MIB that provides read-only support (GET operations but not SET operations) for APS configuration parameters and status information. Any of the parameters that can be set with the `config aps` commands can be accessed using the MIB, and any of the status information displayed by the `show aps` command can also be read using the MIB. For more information on the MIB, see Appendix B.

Configuring Port Tunneling

Port tunneling can be used to encapsulate and transport the raw High-Level Data Link Control (HDLC) encapsulated byte stream from one PoS port to another PoS port across an MPLS network. This allows service providers to tunnel different types of SONET HDLC streams across a non-SONET backbone like Ethernet. The initial implementation of port tunneling requires an MPLS backbone network.

The following ExtremeWare port command has been added to support HDLC tunneling on a PoS module:

```
config ports <portlist> tunnel hdlc [off | mpls]
```

After you configure the PoS port, you can tunnel HDLC encapsulated frames from a PoS port across a SONET or Ethernet based MPLS network. The ingress PoS port encapsulates the entire HDLC frame, including the HDLC header and FCS, inside an Ethernet / MPLS header. HDLC control bytes are de-stuffed on the ingress PoS port. The egress PoS port strips the Ethernet / MPLS header and forwards the HDLC frame. HDLC control bytes are stuffed on the egress PoS ports. HDLC idle bytes, x7E, are not tunneled, but runts and aborted frames are tunneled. Figure 3-20 displays port tunneling between PoS port 1:4 on BlackDiamond switch 1 and PoS port 8:4 on BlackDiamond switch 2 with a PPP link between Customer switch 1 and Customer switch 2. PPP is not terminated on either BlackDiamond switch 1 or BlackDiamond switch 2.

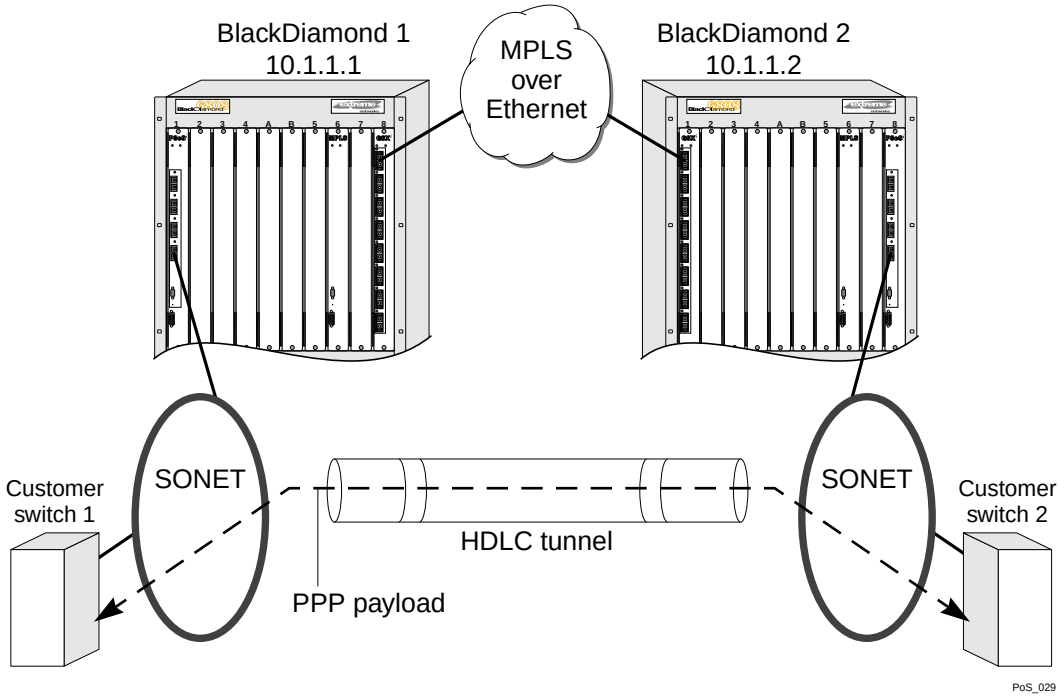


Figure 3-20: Port tunneling via a PPP link

When you configure a PoS port for HDLC tunneling, make sure PPP is not configured and BCP and IPCP are off. Furthermore, the PoS port should be the only port in the VLAN, and an MPLS tls-tunnel should be configured for this VLAN. For more information about MPLS and MPLS commands, see the *MPLS Installation and User Guide*. The payload inside the HDLC can be PPP or another HDLC encapsulated protocol. SONET Automatic Protection Switching (APS) is supported between tunneled PoS ports on the same module or different modules in the same switch. APS is not supported for tunneled PoS ports on different switches. By default, HDLC tunneling is turned off on PoS ports.

The following sections describe how to configure a port tunnel.

Configuring the PoS Port Tunnel

The following configuration commands apply to the PoS module installed in slot 1 of BlackDiamond switch 1, as shown in Figure 3-20.

```
config ppp ipcp off port 1:4
config ppp bcp off port 1:4
create vlan customerx
config vlan customerx add port 1:4
config ports 1:4 tunnel hdlc mpls
```

The following configuration commands apply to the PoS module installed in slot 8 of BlackDiamond switch 2, as shown in Figure 3-20.

```
config ppp ipcp off port 8:4
config ppp bcp off port 8:4
create vlan customerx
config vlan customerx add port 8:4
config ports 8:4 tunnel hdlc mpls
```

The PoS port should be the only port in the VLAN.

Configuring the Ethernet Module

The following configuration commands apply to the Ethernet module installed in slot 8 of BlackDiamond switch 1, as shown in Figure 3-20.

```
create vlan mplsCloud
config vlan mplsCloud add port 8:1
config vlan mplsCloud ipaddress 10.1.1.1/24
enable ipforwarding mplsCloud
config ospf routerid automatic
config ospf add vlan mplsCloud area 0.0.0.0
enable ospf
```

The following configuration commands apply to the Ethernet/MPLS module installed in slot 1 of BlackDiamond switch 2, as shown in Figure 3-20.

```
create vlan mplsCloud
config vlan mplsCloud add port 1:1
config vlan mplsCloud ipaddress 10.1.1.2/24
enable ipforwarding mplsCloud
config ospf routerid automatic
config ospf add vlan mplsCloud area 0.0.0.0
enable ospf
```

For more information about VLANs and OSPF features supported by ExtremeWare, see the ExtremeWare Software User Guide*.*

Configuring the MPLS tls-Tunnel

The following configuration commands create an MPLS tls-tunnel between BlackDiamond switch 1 and BlackDiamond switch 2, as shown in Figure 3-20.

```
config mpls add vlan mplsCloud
config mpls add tls-tunnel BD2 10.1.1.2 customerX tls-labels 8F100 8F200
enable mpls
```

The following configuration commands create an MPLS tls-tunnel between BlackDiamond switch 2 and BlackDiamond switch 1, as shown in Figure 3-20.

```
config mpls add vlan mplsCloud
config mpls add tls-tunnel BD1 10.1.1.1 customerX tls-labels 8F200 8F100
enable mpls
```

For more information about MPLS and MPLS commands, see the MPLS Installation and User Guide*.*

Additional PoS Module Support Topics

This section describes additional command and configuration information related to the use of the PoS modules. This section includes information on the following topics:

- Configuring General Switch Attributes on page 3-101
- Configuring Port Attributes on page 3-102
- Configuring IGMP Attributes on page 3-105
- Configuring Layer 2 and 3 Switching Attributes on page 3-105
- Configuring Access List Attributes on page 3-106
- Changing Image and Configuration Attributes on page 3-106

Configuring General Switch Attributes

Except as described below, the PoS module supports all of the general ExtremeWare switch commands. Table 3-17 describes the changes to existing ExtremeWare general switch commands to support the PoS module. Commands with keywords or parameters shown in italic typeface are existing ExtremeWare commands that have been enhanced to support the PoS module.

Table 3-17: Changes to General Switch Commands

Command	Description of Change
show slot {<slot>}	**Augmented implementation:** For the PoS module, the information displayed by this command will include data about the software images loaded on the module, as well as network processor and GPP status.
config slot <slot> module [f32t | f32f | f48t | g4x | g6x | g8x | g12x | *p3c* | *p12c*]	**Enhanced command:** The p3c and p12c keywords represent the OC-3 PoS module and the OC-12 PoS module, respectively.
show version	**Augmented implementation:** The information displayed by this command will include data about the PoS module and the bootrom version of the PoS module.

Table 3-17: Changes to General Switch Commands (continued)

Command	Description of Change
reboot {time <date> <time> | cancel} {*slot* <*slot*>}	**Enhanced command:** The slot <slot> option was added to the command to make it possible to reboot a module in a specific slot. When you specify this option, the command applies to the PoS module in the specified slot, rather than to the switch.
clear counters	**Augmented implementation:** For the PoS module, this command clears statistics for all of the PoS-related functions: SONET, PPP, NetFlow, DiffServ, and APS.
show diagnostics {<slot>}	**Augmented implementation:** This command displays the result of PoS module diagnostics.
run diagnostics [normal | extended] <slot>	**Enhanced command:** This command runs the PoS module diagnostics.

Configuring Port Attributes

The following ExtremeWare port commands are not supported for the PoS module:

- `show ports {<portlist>} collisions`
- `config ports <portlist> auto off {speed [10 | 100 | 1000]} duplex [half | full]`
- `config ports <portlist> auto on`
- `enable smartredundancy <portlist>`
- `enable sharing <port> grouping <portlist> {port-based | address-based | round-robin}`
- `enable mirroring to <port>`
- `disable learning ports <portlist>`
- `config mirroring add [vlan <name> | port <port> | vlan <name> ports <portlist>]`

Except as described below, the PoS module supports the remainder of the ExtremeWare port commands. Table 3-18 describes the changes to the ExtremeWare port commands to support the PoS module. Commands with keywords or parameters shown in italic typeface are existing ExtremeWare commands that have been enhanced to support the PoS module.

Table 3-18: Changes to Port Commands

Command	Description of Change
disable jumbo-frame ports [<portlist> | all]	**Augmented implementation:** This command applies to PoS ports when disabling jumbo-frame support changes the negotiated maximum receive unit (MRU) size.
disable ports <portlist>	**Augmented implementation:** For PoS modules, this command brings down the PPP link on the specified port, and changes the port status LED to blinking green.
enable jumbo-frame ports [<portlist> | all]	**Augmented implementation:** This command applies to PoS ports when enabling jumbo-frame support changes the negotiated maximum receive unit (MRU) size.
enable ports <portlist>	**Augmented implementation:** For PoS modules, this command enables the PPP link on the specified port, and changes the port status LED to solid green (if no other problems exist).
restart ports <portlist>	**Augmented implementation:** For PoS modules, this command causes the PPP link to be renegotiated.
show ports {<portlist>} info {detail}	**Augmented implementation:** The information displayed by this command includes DiffServ and RED configuration parameters for the PoS module ports.
show ports {<portlist>} qosmonitor {*egress* | *ingress*} {*discards*}	**Enhanced command:** The optional `egress`, `ingress`, and `discards` keywords display information for PoS ports. By default, the command displays transmissions in the egress direction. The ingress keyword causes the command to monitor and display queue statistics for the ingress direction. The discard keyword causes the command to monitor and display packet discard statistics rather than transmission statistics. Currently, the egress, ingress, and discard keywords apply only to PoS ports.
show ports {<portlist>} rxerrors	**Augmented implementation:** Only a subset of the statistics displayed by this command are applicable to PoS ports. The fields that do not apply to PoS ports are displayed with values of all zeroes.

Table 3-18: Changes to Port Commands (continued)

Command	Description of Change
show ports {<portlist>} txerrors	**Augmented implementation:** Only a subset of the statistics displayed by this command are applicable to PoS ports. The fields that do not apply to PoS ports are displayed with values of all zeroes.

Jumbo Frame Support

The Extreme Networks implementation of PPP supports the Link Control Protocol (LCP) maximum receive unit (MRU) option, which specifies the maximum number of octets that a PPP information field can contain and still be received successfully. In the Extreme Networks implementation, the advertised MRU size depends mainly on two factors:

- Whether IPCP or BCP is enabled on the PoS port
- Whether jumbo frame support is enabled on the PoS port

If IPCP is configured on the port and jumbo frame support is not enabled, the Extreme Networks implementation of PPP advertises an MRU of 1500 octets and requires that the peer have an MRU of at least 1500 octets.

If BCP is configured on the port and jumbo frame support is not enabled, the advertised MRU is 24 octets larger than in the corresponding IPCP case. The additional octets are needed to accommodate the larger frame size associated with the bridged format, which includes the MAC header. If VLAN tags are to be transmitted, the peer's MRU must be at least 1520 octets; otherwise, the peer's MRU must be a minimum of 1516 octets.

If IPCP is configured on the port and jumbo frame support is enabled on the port, the advertised MRU size in octets is calculated using the following formula:

(configured jumbo frame MTU – 22)

and the peer is also required to have an MRU at least this large.

If BCP is configured on the port and jumbo frame support is enabled on the port, the peer's MRU must be (configured jumbo frame MTU – 6) octets at a minimum, and at least (configured jumbo frame MTU – 2) octets if VLAN tags are to be transmitted.

Consider these factors when configuring jumbo frame support on a PoS port:

- Because the jumbo frame MTU setting affects the PPP MRU setting of the PoS port and the peer, changing the jumbo frame MTU setting can have the following results:
  - Temporary disruption of the logical connection because the Link Control Protocol might need to terminate the logical connection and then re-establish it with larger MRU sizes.
  - Longer term disruption of the logical connection because of the requirement that the logical connection can only be established when (a) jumbo frame support is enabled on the peer PoS port, and (b) the same jumbo frame MTU size must be configured on both ends of the logical connection when the peer is also a BlackDiamond switch.
- When the jumbo frame size is changed from a value of 8191 or less to a value greater than 8192, any PoS modules that have ports with jumbo frame support enabled must be rebooted for the change to take effect.
- The peer MRU is always allowed to be greater than or equal to the MRU size of the local port.
- Fragmentation and path MTU discovery is performed, but is based on checking the peer's MRU in conjunction with the IP MTU configured for the egress VLAN (which can be set using the `config ip-mtu <number> vlan <name>` command), rather than the jumbo frame MTU setting.

For more information on the ExtremeWare jumbo frame commands, see the *ExtremeWare Software User Guide.*

Configuring IGMP Attributes

For more information on the ExtremeWare IGMP commands, see the *ExtremeWare Software User Guide.*

Configuring Layer 2 and 3 Switching Attributes

All of the IP routing protocols are supported: RIP, OSPF, BGP, DVMRP, and PIM.

When BCP is enabled on a PoS port, IPX RIP and SAP are supported.

Configuring Access List Attributes

For more information on the ExtremeWare access list commands, see the *ExtremeWare Software User Guide*.

On the OC-3 PoS module, the access list functions apply to port pairs, where ports 1 and 2 are a pair, and ports 3 and 4 are a pair. This pairing scheme means that the ports in a given pair share the same access lists: ports 1 and 2 share the same lists, while ports 3 and 4 share their access lists. For example, if an access list is configured for port 1, that access list also applies to port 2, and vice versa. This restriction does not apply to the OC-12 PoS module.

Changing Image and Configuration Attributes

Except as described below, the PoS module supports all of the ExtremeWare commands associated with managing image and configuration attributes. For more information about these commands and operations, see the "Software Upgrade and Boot Options" appendix in the *ExtremeWare Software User Guide*. Table 3-19 describes the command changes to support the PoS module. Commands with keywords or parameters shown in italic typeface are existing ExtremeWare commands that have been enhanced to support the PoS module.

Table 3-19: Changes to Image Commands

Command	Description of Change
download bootrom [<ipaddress> | <hostname>] <filename> *{slot <slot>}*	The slot <slot> option has been added to this command to support downloading the bootrom code to a specified PoS module rather than to one of the switch's MSMs.
download image [<ipaddress> | <hostname>] <filename> {primary | secondary} {*slot* <*slot*>}	The slot <slot> option has been added to this command to support downloading of images to a specified PoS module. When you enter the command with this option, the image is downloaded to the module in the specified slot rather than to one of the switch's image partitions.
use image [primary | secondary] {*slot* <*slot*>}	The slot <slot> option has been added to this command to select which image will load on the module in the specified slot on the next reboot.

A ExtremeWare Command Compatibility Information Related to the PoS Module

This appendix summarizes the ExtremeWare command changes and additions to support for the PoS module, and includes information on the following topics:

- New commands added to support the PoS module on page A-1
- Commands changed to support the PoS module on page A-5
- Commands not supported by the PoS module on page A-8

New Commands

New commands have been added to ExtremeWare to support the following functions:

- SONET
- PPP
- MPLSCP
- QoS and DiffServ
- Flow statistics
- Automatic Protection Switching
- 802.1Q tag mapping and tag nesting
- Port tunneling

New ExtremeWare Commands

Table A-1 lists the new ExtremeWare commands that have been added to support the PoS module. For more information on these commands, see Chapter 3.

Table A-1: New ExtremeWare Commands

Command	Description
config aps <group#> [nonrevert | revert <minutes>]	Configures APS operation in either nonrevertive or revertive switching mode.
config aps <group#> add <port> [working | protection <ipaddress>]	Adds a SONET port to an APS group.
config aps <group#> authenticate [off | on <string>]	Configures authentication of APS control messages.
config aps <group#> delete <port>	Deletes a SONET port from an APS group.
config aps <group#> force [off | working | protection]	Requests that an APS group be forced to use a specified line as the active line.
config aps <group#> lockout [off | on]	Controls whether a switch to the protection line is locked out.
config aps <group#> manual [off | working | protection]	Manually determines whether an APS group uses its working line or its protection line as the active line.
config aps <group#> timers <seconds> <consecutive_misses>	Sets the values of the timers used in the APS hello protocol that is exchanged between the working and protection switches for an APS group.
config diffserv dscp-mapping <input_codepoint>/<output_codepoint> ports <portlist> {egress {no-congestion | congestion} | ingress}	Configures a mapping between an input DiffServ code point (DSCP) and an associated output DSCP for the specified PoS ports.
config dot1q tagmapping <input_vlanid/output_vlanid> ports <portlist> {egress {priority <priority>} | ingress {priority <priority>}}	Configures the VLAN tag mapping tables for a PoS port.
config dot1q tagnesting {<vlanid> | <vlanid_range>} [off | pop | push <new_vlanid> {priority <priority>}] ports <portlist> {egress | ingress}	Configures the VLAN tag nesting attributes for a PoS port.
config flowstats export {<group#>} [add | delete] [<ipaddress> | <hostname>] <udp_port>	Configures the flow-collector devices to which NetFlow datagrams are exported.

Table A-1: New ExtremeWare Commands (continued)

Command	Description
config flowstats filter <filter#> {aggregation} {export <group#>} ports <portlist> [ingress | egress] <filterspec>	Configures a flow record filter for the specified SONET ports.
config flowstats source ipaddress <ipaddress>	Configures the IP address that is to be used as the source IP address for NetFlow datagrams to be exported.
config flowstats timeout <minutes> ports <portlist>	Configures the timeout value for flow records on the specified SONET ports.
config ports <portlist> tunnel hdlc [off | mpls]	Enables tunneling for HDLC encapsulated frames from a SONET port through an MPLS network.
config ppp [bcp [on | off] | ipcp [on {peer-ipaddress <ipaddress>} | off]] ports <portlist>	Configures the Network Control Protocol that will run on the specified PPP ports.
config ppp authentication [off | chap | pap | chap-pap] ports <portlist>	Configures authentication on the specified PPP ports.
config ppp delayed-down-time <seconds> ports <portlist>	Configures the delayed-down-time interval used by PPP for the specified ports.
config ppp echo [<seconds> <consecutive_misses> | off] ports <portlist>	Configures the link maintenance protocol on the specified ports.
config ppp pos checksum [32 | 16] ports <portlist>	Configures the size of the HDLC Frame Check Sequence (FCS) to be used on the specified SONET ports.
config ppp pos scrambling [on | off] ports <portlist>	Specifies whether the payload data should be scrambled on the specified ports.
config ppp quality [off | <required_percent> {<seconds>}] ports <portlist>	Configures the Link Quality Monitoring (LQM) protocol on the specified ports.
config ppp user <name> {encrypted} {<password>} ports <portlist>	Configures the user name and password that the specified PPP port uses in the event the PPP peer requests authentication.
config red min-threshold <percent> ports <portlist>	Configures the minimum queue length threshold for RED operation on the specified PoS ports.
config sonet clocking [line | internal] ports <portlist>	Configures the clocking source for the specified SONET ports.
config sonet framing [sonet | sdh] ports <portlist>	Configures the framing type for the specified SONET ports.
config sonet signal label [auto | <hex_octet>] ports <portlist>	Configures the Signal Label value for the specified SONET ports.

Table A-1: New ExtremeWare Commands (continued)

Command	Description
config sonet threshold signal degrade <error_rate> ports <portlist>	Configures the Signal Degrade threshold for the specified SONET ports.
config sonet threshold signal fail <error_rate> ports <portlist>	Configures the Signal Failure threshold for the specified SONET ports.
config sonet trace path <id_string> ports <portlist>	Configures the Path Trace Identifier string for the specified SONET ports.
config sonet trace section [<id_byte> | string <id_string>] ports <portlist>	Configures the Section Trace Identifier for the specified SONET ports.
create aps <group#>	Creates an APS group with the specified group number.
delete aps <group#>	Deletes the specified APS group.
disable aps	Disables the APS function for an entire switch.
disable flowstats filter <filter#> ports <portlist> [ingress | egress]	Disables a specified flow record filter for the specified SONET ports.
disable flowstats ping-check {<group#>}	Disables the flow statistics ping-check function for a specified group of collector devices.
disable flowstats ports <portlist>	Disables the flow statistics function on the specified SONET ports.
enable aps	Enables the APS function for an entire switch.
enable flowstats filter <filter#> ports <portlist> [ingress | egress]	Enables a specified flow record filter for the specified SONET ports.
enable flowstats ping-check {<group#>}	Enables the flow statistics ping-check function for a specified group of collector devices.
enable flowstats ports <portlist>	Enables the flow statistics function on the specified SONET ports.
show aps {<group#>} {detail}	Displays APS group status information.
show flowstats {<portlist> | export {<group#>} {detail}}	Displays status information for the flow statistics function.
show ppp {<portlist>} {detail}	Displays status information for PPP ports.
show sonet {<portlist>} {detail}	Displays SONET port status.
unconfig aps <group#>	Resets the APS group configuration parameters to their default values.
unconfig diffserv dscp-mapping ports <portlist>	Resets the DSCP mapping tables for the specified PoS ports to their default values.

Table A-1: New ExtremeWare Commands (continued)

Command	Description
unconfig flowstats ports <portlist>	Resets the flow statistics configuration parameters for a specified SONET port to their default values.
unconfig ppp ports <portlist>	Resets the PPP configuration parameters for the specified ports to their default values.
unconfig sonet ports <portlist>	Resets the configuration parameters of the specified SONET port to their default values.

Changed Commands

Changes to existing ExtremeWare commands fall into two categories:

- Syntax enhancements to support the PoS module
- Implementation changes to support the PoS module

Syntax changes are visible: keywords or arguments may have been added or changed to make it possible to configure the behavior associated with the PoS module. Implementation changes may be visible, taking the form of different input behavior, such as blocking an attempt at specifying a PoS port for a given command, or in additional information in the results of a command, such as in a `show ports` command.

Commands not described in this section are supported by the PoS module as described in the ExtremeWare Software User Guide.

Table A-2 is an alphabetical list of the existing ExtremeWare commands whose syntax has been enhanced to support the PoS module. New keywords and arguments are shown in italic typeface.

Table A-2: Summary of Commands with Enhanced Syntax

Command	Description
config diffserv examination code-point <code_point> qosprofile <qosprofile> ports <portlist> {*low-drop-probability* | *high-drop-probability*}	Added optional keywords for low-drop-probability and high-drop-probability.

Table A-2: Summary of Commands with Enhanced Syntax (continued)

Command	Description
config red [drop-probability | *low-drop-probability* | *high-drop-probability*] <percent> {*ports* <*portlist*>}	Added keywords for low-drop-probability and high-drop-probability; added optional keyword and argument to specify ports.
config qosprofile <qosprofile> {minbw <percent>} {maxbw <percent>} {priority <level>} {minbuf <percent>} {maxbuf <percent>} {<portlist>} {*egress* | *ingress*}	Added optional egress and ingress keywords.
config slot <slot> module [f32t | f32f | f48t | g4x | g6x | g8x | g12x | *p3c* | *p12c*]	Added keywords to specify the OC-3 and OC-12 PoS modules.
create account [admin | user | *pppuser*] <username> {encrypted} {<password>}	Added pppuser keyword.
disable red ports <portlist> {*queue* <*queue#*>}	Added optional keyword and argument to specify the queue number.
download bootrom [<ipaddress> | <hostname>] <filename> *{slot <slot>}*	Added optional keyword and augment to specify the slot.
download image [<ipaddress> | <hostname>] <filename> [primary | secondary} {*slot* <*slot*>}	Added optional keyword and argument to specify the slot.
enable red ports <portlist> {*queue* <*queue#*>}	Added optional keyword and argument to specify the queue number.
reboot {time <date> <time> | cancel} {*slot* <*slot*>}	Added optional keyword and argument to specify the slot where the module is installed.
show ports {<portlist>} qosmonitor {*egress* | *ingress*} {*discards*}	Added optional egress and ingress keywords; added optional discards keyword.
use image [primary | secondary] {*slot* <*slot*>}	Added optional keyword and argument to specify the slot where the module is installed.

Table A-3 is an alphabetical list of the existing ExtremeWare commands whose implementation has been augmented to support the PoS module.

Table A-3: Summary of Commands with Augmented Implementation

Command	Description
clear counters	For the PoS module, this command clears statistics for all of the PoS-related functions: SONET, PPP, NetFlow, DiffServ, and APS.
disable jumbo-frame ports [<portlist> | all]	This command applies to PoS ports when disabling jumbo-frame support changes the negotiated maximum receive unit (MRU) size.

Table A-3: Summary of Commands with Augmented Implementation (continued)

Command	Description
disable ports <portlist>	For PoS modules, this command brings down the PPP link on the specified port, and changes the port status LED to blinking green.
enable jumbo-frame ports [<portlist> | all]	This command applies to PoS ports when enabling jumbo-frame support changes the negotiated maximum receive unit (MRU) size.
enable ports <portlist>	For PoS modules, this command enables the PPP link on the specified port, and changes the port status LED to solid green (if no other problems exist).
restart ports <portlist>	For PoS modules, this command causes the PPP link to be renegotiated.
show diagnostics {<slot>}	This command displays results of diagnostics for the PoS module.
show ports {<portlist>} info {detail}	The information displayed by this command will include new DiffServ and RED configuration parameters.
show ports {<portlist>} rxerrors	Only a subset of the statistics displayed by this command are applicable to PoS ports. The fields that do not apply to PoS ports are displayed with values of all zeroes.
show ports {<portlist>} txerrors	Only a subset of the statistics displayed by this command are applicable to PoS ports. The fields that do not apply to PoS ports are displayed with values of all zeroes.
show slot <slot>	For the PoS module, the information displayed by this command will include data about the software images loaded on the module, as well as status information on the network processors and GPP.
show version	The information displayed by this command will include data about the PoS I/O module and the bootrom version of the PoS I/O module.

Commands and Functions Not Supported

None of the ExtremeWare commands associated with the following functions are supported for PoS ports:

- Extreme Standby Routing Protocol (ESRP)
- Dynamic Link Context System (DLCS)
- Intra-Subnet QoS™ (ISQ)
- Remote Monitoring (RMON)

Table A-4 is an alphabetical list of the existing ExtremeWare commands that are not supported for the PoS module.

Table A-4: Summary of Commands Not Supported for PoS Ports

Command	Description
config gvrp {listen | send | both | none] ports <portlist>	The Generic VLAN Registration Protocol (GVRP) is not supported on PoS module ports.
config mirroring add [vlan <name> | port <port> | vlan <name> ports <portlist>	Port mirroring is not supported on PoS module ports.
config ports <portlist> auto off {speed [10 | 100 | 1000]} duplex [half | full]	This command is an Ethernet-specific command.
config ports <portlist> auto on	This command is an Ethernet-specific command.
config vlan <name[1]> [add | delete] ports <portlist> {tagged | untagged} {nobroadcast}	**Usage restrictions apply.** PoS I/O module ports do not support Protocol-Based VLANs or MAC Address VLANs; otherwise, PoS ports support the optional tagged and untagged keywords when BCP is enabled and ignore them when IPCP is enabled.
config vlan <name[2]> protocol <protocol_name>	**Usage restrictions apply.** The command `config vlan <name> protocol any` is supported, because it can be used to configure the default VLAN for PoS ports.
disable learning ports <portlist>	Learning is always enabled.
enable dlcs ports <portlist>	No DLCS functions are supported for a PoS port when the port is a member of a VLAN.
enable esrp vlan <name>	Not supported when a PoS port is a member of the VLAN specified as <name>.

Table A-4: Summary of Commands Not Supported for PoS Ports (continued)

Command	Description
enable isq <name>	Not supported when a PoS port is a member of the VLAN specified as <name>.
enable mac-vlan mac-group [any | group_number] ports <portlist>	PoS I/O module ports do not support Protocol-Based VLANs or MAC Address VLANs.
enable mirroring to <port>	Port mirroring is not supported on PoS module ports.
enable sharing <port> grouping <portlist>	Load-sharing port groups are not supported for PoS module ports.
enable smartredundancy <portlist>	This command is an Ethernet-specific command.
show ports {<portlist>} collisions	This command is an Ethernet-specific command.

1. When <name> is a protocol-based VLAN.
2. When a PoS port is a member of the VLAN specified as <name>.

B Supported MIBs and Standards

This appendix lists the software standards and management information bases (MIBs) supported in relation to the PoS modules.

For a broader list of the software standards supported by ExtremeWare as a whole, see the "Supported Standards" appendix in the ExtremeWare Software User Guide.

This appendix includes information on the following topics:

- SONET/SDH Support on page B-2
- PPP Support on page B-2
- QoS and DiffServ Support on page B-3
- Flow Statistics Support on page B-4
- Automatic Protection Switching Support on page B-4

SONET/SDH Support

This section lists the Synchronous Optical Network/Synchronous Digital Hierarchy (SONET/SDH) related standards and SNMP MIBs that are supported for the PoS modules.

Standards Supported for SONET/SDH

The Extreme Networks SONET/SDH implementation complies with the following standards:

- GR-253-CORE, *Synchronous Optical Network (SONET) Transport Systems: Common Generic Criteria*, Bellcore, Issue 2, Revision 2, January 1999.
- ANSI T1.105.02-1995, *Synchronous Optical Network (SONET)—Payload Mappings*, American National Standards Institute, 1995.
- ITU-T G.707 (03/96), *Network Node Interfaces for the Synchronous Digital Hierarchy (SDH)*, March 1996.

MIBs Supported for SONET/SDH

A subset of RFC 2558, *Definitions of Managed Objects for the SONET/SDH Interface Type*, has been implemented. The Virtual Tributary (VT) group and the Section/Line/Path interval tables were not implemented. Read-only support (GET operations, but not SET operations) has been implemented for the remainder of the MIB.

PPP Support

This section lists the PPP-related software standards and SNMP MIBs that are supported for the PoS modules.

Standards Supported for PPP

In addition to the MIB support described above, the Extreme Networks PPP implementation complies with the following standards:

- RFC 1661: *The Point-to-Point Protocol*
- RFC 1662: *PPP in HDLC-like Framing*

- RFC 2615: *PPP over SONET/SDH*
- RFC 1334: *PPP Authentication Protocols* (specifies PAP)
- RFC 1994: *PPP Challenge Handshake Authentication Protocol (CHAP)*
- RFC 1989: *PPP Link Quality Monitoring*
- RFC 1332: *The PPP Internet Protocol Control Protocol (IPCP)*
- RFC 2878: *The PPP Bridging Control Protocol (BCP)*
- RFC 1191: *Path MTU Discovery*
- RFC 3032: *MPLS Label Stack Encoding*

MIBs Supported for PPP

The interface counters in MIB-II (RFC 1213) are supported for PPP.

Support for read-only operations (GET operations, but not SET operations) is provided for the following PPP MIBs:

- RFC 1471: *The Definitions of Managed Objects for the Link Control Protocol of the Point-to-Point Protocol*
- RFC 1472: *The Definitions of Managed Objects for the Security Protocols of the Point-to-Point Protocol*
- RFC 1474: *The Definitions of Managed Objects for the IP Network Control Protocol of the Point-to-Point Protocol*
- RFC 1473: *The Definitions of Managed Objects for the Bridge Control Protocol*

QoS and DiffServ Support

This section lists the DiffServ-related software standards that are supported for the PoS modules.

Standards Supported for DiffServ

The Extreme Networks implementation of RED is based on the well-known paper *Random Early Detection Gateways for Congestion Avoidance*, by Sally Floyd and Van Jacobson. The Extreme Networks implementation of RED also complies with the

recommendations published in RFC 2309, *Recommendations on Queue Management and Congestion Avoidance in the Internet*.

The Extreme implementation of DiffServ complies with the following standards:

- RFC 2474: *Definition of the Differentiated Services Field (DS Field) in the IPv4 and IPv6 Headers*
- RFC 2475: *An Architecture for Differentiated Services*
- RFC 2597: *Assured Forwarding PHB Group*
- RFC 2598: *An Expedited Forwarding PHB*

Flow Statistics Support

This section lists the flow statistics MIBs that are supported for the PoS modules.

MIBs Supported for Flow Statistics

Because no standard MIBs are defined for managing the NetFlow function, Extreme Networks has defined and implemented an enterprise MIB that provides read-only support (GET but not SET operations) for NetFlow configuration parameters and status information. Any of the parameters that can be set with the `config flowstats` commands can be accessed through using the MIB, and any of the status information displayed by the `show flowstats` command can also be read using the MIB.

You can download the NetFlow enterprise MIB from the Extreme Network World Wide Web site at the following URL:

http://www.extremenetworks.com/support/documentation.asp

Automatic Protection Switching Support

This section lists the APS-related standards and MIBs that are supported for the PoS modules.

Standards Supported for APS

In addition to the MIB support described above, the Extreme Networks APS implementation complies with the following standards:

- GR-253-CORE, *Synchronous Optical Network (SONET) Transport Systems: Common Generic Criteria*, Bellcore, Issue 2, Revision 2, January 1999.
- ANSI T1.105.01-1998, *Synchronous Optical Networks (SONET)—Automatic Protection Switching*, American National Standards Institute, 1998.
- ITU-T G.783 (04/97), *Characteristics of Synchronous Digital Hierarchy (SDH) Equipment Functional Blocks*, April 1997.

MIBs Supported for APS

Because no standard MIBs are defined for managing the APS function, Extreme Networks has defined and implemented an enterprise MIB that provides read-only support (GET but not SET operations) for APS configuration parameters and status information. Any of the parameters that can be set with the `config aps` commands can be accessed through using the MIB, and any of the status information displayed by the `show aps` command can also be read using the MIB.

You can download the APS enterprise MIB from the Extreme Network World Wide Web site at the following URL:

http://www.extremenetworks.com/support/documentation.asp

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